Sky and TELESCOPE

In This Issue:

Messier and His Catalogue — I

Some Demonstrations for the Classroom

A Small Planetarium in Detroit

Flaming Stars

Northern and Southern Star Charts

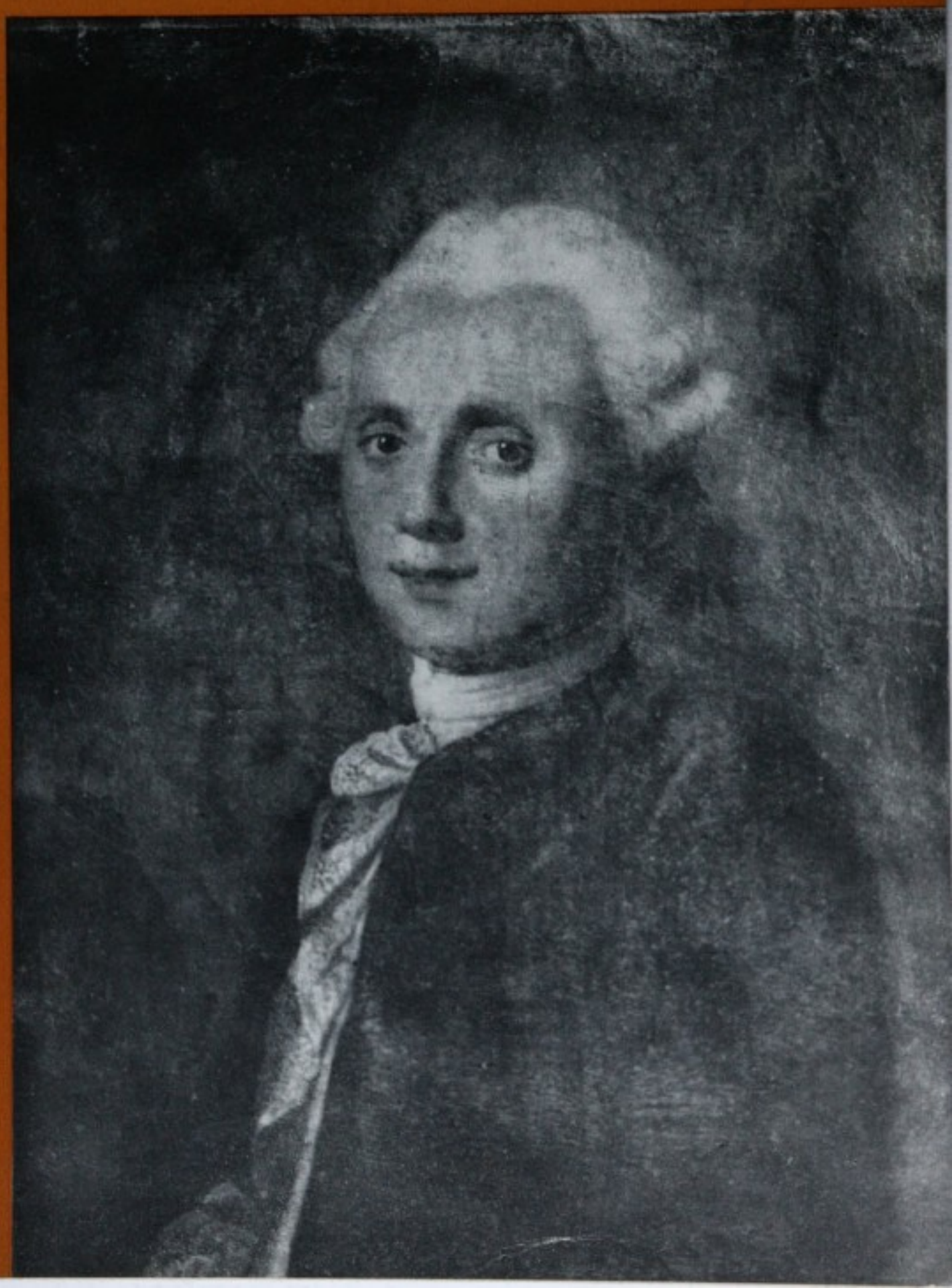
★

Vol. XII, No. 10

AUGUST, 1953

Whole Number 142

★



Charles Messier
(1730 - 1817)

Sky and TELESCOPE

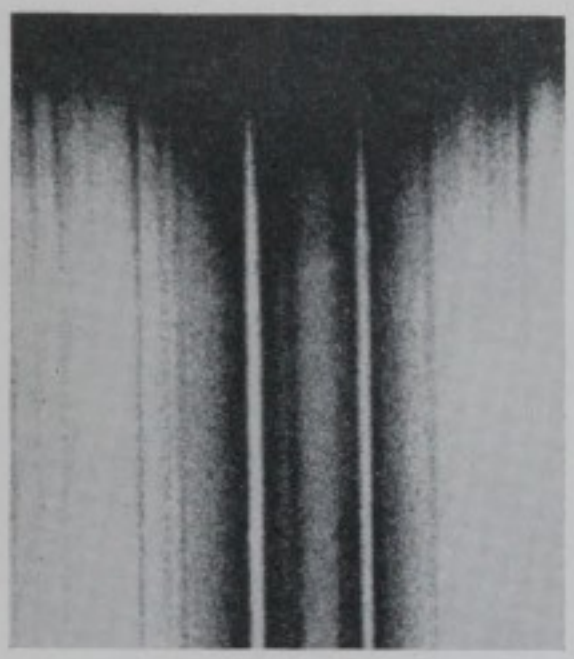
Copyright, 1953, by
Sky Publishing Corporation

Charles A. Federer, Jr., *Editor*; Helen S. Federer, *Managing Editor*
EDITORIAL ADVISORY BOARD: *Clement S. Brainin*, Amateur Astronomers Association, New York; *Edward A. Halbach*, Milwaukee Astronomical Society; *Donald H. Menzel*, Harvard College Observatory; *Paul W. Merrill*, Mount Wilson Observatory (retired); *Charles H. Smiley*, Ladd Observatory; *Percy W. Witherell*, Bond Astronomical Club.

UV SOLAR SPECTRUM

Rocket specialists at such places as the Applied Physics Laboratory, Johns Hopkins University, and the Naval Research Laboratory, are in the enviable position of being able to send their observing apparatus 100 miles or more into the air, where regions of the solar spectrum, of wave lengths shorter than 3000 angstroms, can be regularly recorded. Before the age of rockets, this part of the sun's radiation was inaccessible to our earth-bound spectrographs because it is absorbed by the ozone layers of the atmosphere.

Rapid progress is being made. In the *Astrophysical Journal* for January, Harold E. Clearman, Applied Physics Laboratory, lists 248 spectral lines beginning with an iron line at 2284.9 angstroms and ending with a line at 3000.9 angstroms. For each line the relative intensity is given, and the originating element or elements have been identified in about 90 per cent of the cases.



A small portion of the solar spectrum near 2800 angstroms, photographed from an Aerobee rocket on September 3, 1952. The contour of the absorption lines is given, approximately, by the shape of the upper edge of the spectrum. The ionized magnesium lines at wave lengths 2795.523 and 2802.698 angstroms are present as intense emission cores at the centers of broad absorption features. As expected from theory, the short-wave-length member of the pair is strongest both in emission and absorption. Naval Research Laboratory photo.

In this same issue of the *Astrophysical Journal*, F. S. Johnson, J. D. Purcell, R. Tousey, and N. Wilson, of the Naval Research Laboratory, present a new photograph of the doublet of ionized magnesium (Mg II) at 2800 angstroms in the solar spectrum. This remarkable picture was obtained with a diffraction grating of 40 centimeters radius, 15,000 lines to the inch, made by Bausch and Lomb and blazed for the extreme ultraviolet, second order. The portion of the spectrum shown here was made between 77 and 85 kilometers above sea level, during an Aerobee rocket flight on September 3, 1952, from White Sands Proving Ground.

These lines of magnesium correspond to the H and K lines of ionized calcium in the violet portion of the sun's visible spectrum. In an article on rocket spectroscopy in the *Journal* of the Optical Society of America, April, 1953, Dr. Tousey points out that these are the best pictures of these prominent ultraviolet lines so far obtained. One of the new spectra made on this same flight extends to 1800 angstroms, "and then becomes obscured by fog, caused by a tiny light leak in the casette, which lay in the desert exposed to full sunlight for over a week before it was found."

ANNOUNCEMENT

On July 1st, Dr. Joseph Ashbrook joined the editorial staff of **Sky and Telescope.** He was an instructor at Yale University from 1946 to 1950, and has been assistant professor of astronomy there for the past three years. A native of Philadelphia, Dr. Ashbrook graduated from Johns Hopkins University and obtained a master's degree from the Case Institute of Technology. Specializing in the study of variable stars, he received his doctorate at Harvard University in 1947.

Vol. XII, No. 10 August, 1953
Whole Number 142

CONTENTS

COVER: The famous compiler of the first catalogue of nebulae and clusters, Charles Messier (June 26, 1730-April 12, 1817), as painted by Desportes. Messier is shown here at the age of 40, about the time his first memoir and the catalogue were presented. Bernard Roy, conservator of the department of museums at Nantes, and former owner of this portrait and its companion of Madame Messier (page 256), describes a long notice, written by Messier and attached to the back of the picture, "This was a pleasant monument to human vanity, and the enumeration of all his titles." The cover painting is shown here as it appeared before the portraits were restored by the Louvre, and is reproduced by courtesy of Mr. Roy. (See page 255.)

MESSIER AND HIS CATALOGUE — I — Owen Gingerich 255
SOME DEMONSTRATIONS FOR THE CLASSROOM — William A. Calder 259
A SMALL PLANETARIUM IN DETROIT — Charles A. Lewis 260
FLAMING STARS — Otto Struve 261

Amateur Astronomers 266
Books and the Sky 268
Gleanings for ATM's 271
News Notes 258
Observer's Page 275
Southern Stars 278
Stars for August 279

BACK COVER: The galactic nebula NGC 6618, M17, in Sagittarius, commonly known as the Omega nebula, photographed in red light with the 200-inch Hale telescope. The nebula is located at R.A. $18^h\ 17^m\ 9^s$, $-16°\ 12'$ (1950); it measures 2 by 10 minutes of arc, and is at a distance of about 3,000 light-years. North is at the left. Mount Wilson and Palomar Observatories photo.

SKY AND TELESCOPE is published monthly by Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass. Entered as second class matter, April 28, 1939, at the Post Office, Boston, Mass., under Act of March 3, 1879; accepted for mailing at the special rate of postage provided in Paragraph 4, Section 538, Postal Laws and Regulations.

Subscriptions: $4.00 per year in the United States and possessions, and to Latin-American countries; $7.00 for two years. Add $1.00 per year for Canada and for all other foreign countries, making the total subscription $5.00 per year and $9.00 for two years. Canadian and foreign remittances should be made in United States currency. Single copies, 35 cents, foreign 45 cents. Circulation staff: Betty G. Dodd, manager; Nancy R. Bolton; Virginia K. Cox.

All notices of change of address must be sent one month in advance and accompanied by old and new addresses, or we cannot make the proper change. When sending your renewal order, or writing in regard to your subscription, your current mailing address must be given. For most efficient handling of your subscription, please return our bill form with your renewal payment.

Editorial and advertising offices: Harvard College Observatory, Cambridge 38, Mass. Unsolicited articles and pictures are welcome, bearing adequate return postage, but we cannot guarantee prompt editorial attention, nor are we responsible for the return of unsolicited manuscripts.

The articles in SKY AND TELESCOPE, beginning with Vol. XII, are indexed in THE READERS' GUIDE TO PERIODICAL LITERATURE.

Among the astronomers of his day, Charles Messier was famous as a discoverer of comets, including that of 1764. The paths of comets were recorded on elaborate specially drawn charts; this one by Messier was published in the same book as Messier's original catalogue, the 1771 volume of the history of the French Royal Academy of Sciences.

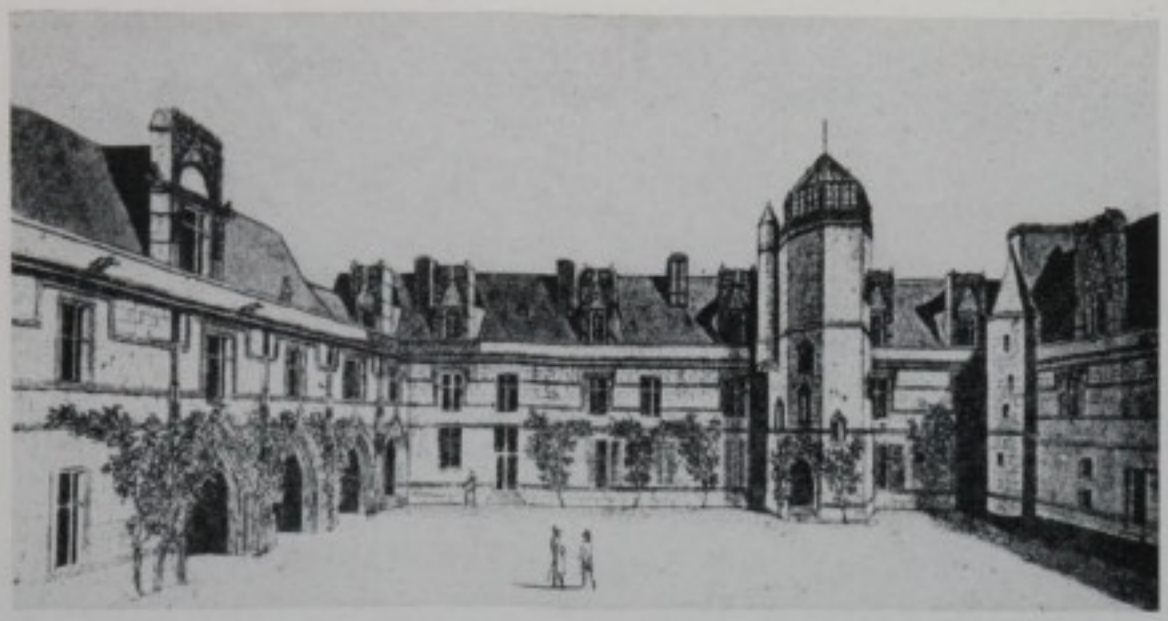
MESSIER AND HIS CATALOGUE--I

BY OWEN GINGERICH, *Harvard College Observatory*

IN THE MIDDLE of the 18th century, astronomy stood at the threshold of a great observational age. Flamsteed and Bradley had already made their important contributions to positional astronomy. Halley, Roemer, and Hevelius were names of history. But the real telescopic observers were yet to come. In 1758 Dollond would perfect the achromat, and within a few decades the great reflectors of Herschel would probe into the unknown depths of the heavens. But it would be for a Frenchman, Charles Messier, whose first love was comets, to build the foundation for telescopic sidereal astronomy with his catalogue of nebulae.

Messier, with his quaint mixture of the old and new, typifies the enthusiasm with which astronomers met the improved techniques. To 20th-century astronomers his fascination for comets appears misguided; with modern concepts of the vastness of the universe, comets appear relatively insignificant. But to the astronomer of 200 years ago, it was the static, nondescript nebulae which were trivial. To the 1750 astronomer, only about 50 comets were known since the beginning of time; within the next half century Messier personally observed nearly the same number.

The successful recovery of Halley's comet, in 1759, a great triumph for the Newtonian theory, added further impetus to the study of comets. Messier's first fame, in fact, came in connection with this comet. Almost eight years earlier, in October, 1751, as an orphan 21 years old, he had come to Paris from his home at Badouvillier, Lorraine, to seek his fortune. The astronomer Joseph Nicolas Delisle hired him as a draftsman, and as a recorder for astronomical observations. Messier first set to work copying a map of the great wall of China. For this, which required a large space, Delisle assigned him a long hall in the College of France. The unheated corridor was rather uninviting in winter, but, as Delambre later commented, this was appropriate for a future observational astronomer. For, in addition to the drafting work, Messier was instructed in the use of the astronomical instruments. By 1754 he was an experienced observer, handling the majority of the work. Shortly afterward, Messier obtained the position of



The Hôtel de Cluny as it appeared in Messier's day. It was built in the late 15th century by Abbot Jacques of Amboise, as a temporary residence for abbots of the Cluny order and their guests. In 1748, Delisle became one of the residents, and from his death in 1768 to 1817 Messier had his residence as well as observatory in the building. Lalande also lived here part of this time. The Marine Observatory was in the solid octagonal tower, shown below as it appears today. From the "Bulletin" of the French Astronomical Society, 1917.

clerk at the Marine Observatory in Paris.

At this time astronomers were anticipating the first predicted return of Halley's comet. Delisle had a large map drawn, showing the routes by which the comet would have to travel to arrive at perihelion on various days. No one doubted that by this scheme Delisle's observing assistant, Messier, would be the first to discover the comet, and then the pair would hasten to announce it.

For 18 months Messier systematically searched, but without success, for actually he had been misled by Delisle's careful maps! Thus, on Christmas night, 1758, a gentleman farmer in Saxony named Palitzsch made the first observation of the returning object. Some days later it was observed by others in Germany as well. But by an extraordinary chance, news of the discovery was delayed over three months in reaching France.

Meanwhile, a month after the original discovery, on January 21, 1759, Messier independently found the comet. Delisle, who had become a gouty old individualist, refused to permit his assistant to announce the observations for two months, until the news of Palitzsch's discovery became known in France. By then the comet was lost in the twilight at perihelion passage, and the other astronomers, enraged at Delisle's obstinacy, refused to consider as authentic Messier's observations up to that time. On the other hand, Delisle would not believe the story of the "poor Saxon peasant who accidentally found the comet with his naked eye." The story is occasionally repeated today, although actually Palitzsch had used a telescope and was specifically searching for the comet. Delisle followed the same reproachable secretive procedure with two other Messier comets; his conduct is all the more inexplicable as he did not use the observations for any particular purpose.

Shortly afterward Delisle retired; Messier continued his work from the tower observatory at the Hôtel de Cluny in Paris. He discovered the comet of 1764, and by a chance naked-eye view he saw that of 1766. For about 15 years nearly all comet discoveries were made by Messier, so that he almost considered them his own property. One perhaps legendary anecdote concerns the death of his wife, which prevented the discovery of a comet he had been watching for. Messier was in despair when his rival, Montagne de Limoges, found the object first. When someone spoke to him of the loss he had suffered, Messier would reply, always thinking of the comet, "Alas! I have discovered a dozen of them; Montagne had to take away the 13th!" And then tears would come to his eyes, but remembering he should be weeping for his wife, he would exclaim, "Ah, the poor woman!" Altogether Messier claimed to have discovered 21 comets in his lifetime; modern astronomers with their more discriminating standards of what constitutes a discovery would reduce this number to perhaps 15.

But comets alone did not claim Messier's time. He was an ardent observer of occultations, transits, and eclipses, and his notebooks were filled with sunspot and meteorological observations as well. Yet seldom, if ever, did Messier do more than tabulate the observations. For instance, invariably it was his as-

The present-day appearance of the observing tower of the Hôtel de Cluny, which became an art museum in 1844, as it still is.

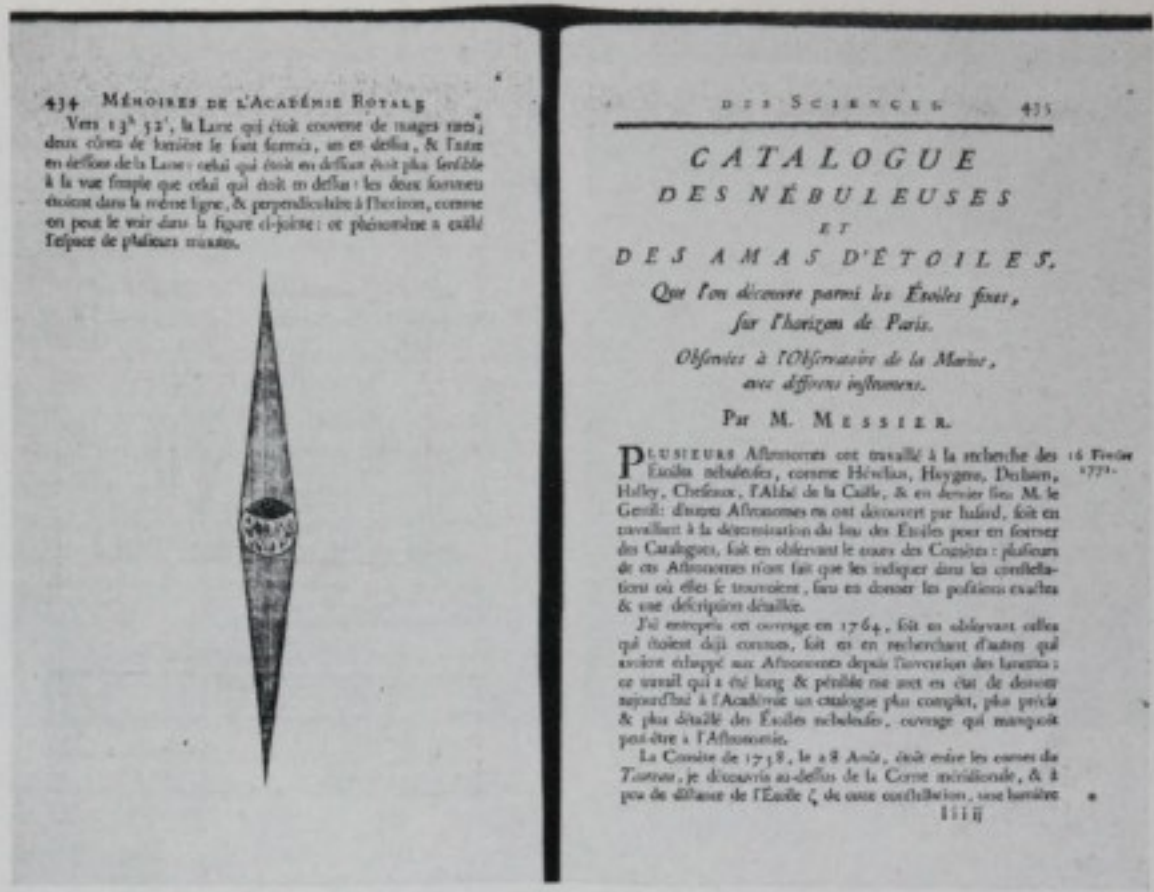
A portrait of Madame Charles Messier, companion to the picture on the front cover, as it appeared prior to its restoration by the Louvre. It is reproduced by courtesy of Bernard Roy, former owner, who writes, "Messier gave her name [on the back of the picture] and seemed very proud that she belonged to a noble family from Lorraine."

sociates who reduced his comet positions, to determine the orbital elements.

Nevertheless, Messier's comet discoveries brought him considerable fame. He aspired to become a member of the exclusive Académie Royale des Sciences, but its scholars were reluctant to admit a mere observer. On several occasions Messier's name was proposed, even for other sections than astronomy. In 1763 Messier tied with Jeaurat for an open place in the academy, but on the second ballot lost. Meanwhile his fame spread outside France, so that after the death of Lacaille in 1762 he was generally considered the leading French astronomer. In 1758 he was already a member of the Royal Academy in London, and later a map of a comet sent to the King of Prussia brought him membership in the Berlin academy. At the recommendation of La Harpe in Russia, Messier was named to the academy of St. Petersburg. Within the next few years he joined half a dozen other societies. By this time the French academicians took more notice of Messier, and he was finally admitted, in 1770.

Almost immediately Messier contributed the first of a great number of astronomical memoirs in the journal of the academy. The very first of these provides his most enduring bid to fame, for this was the "Catalogue des Nébuleuses et des amas d'Etoiles, que l'on découvre parmi les Etoiles fixes, sur l'horizon de Paris," the first installment of the famous Messier catalogue.

The list of nebulae had been a long time in the making. The first object, the Crab nebula in Taurus, was discovered on August 28, 1758, while Messier was following a comet he had found two weeks earlier. As was the case for most of the later objects, the nebula in Taurus was duly plotted on the appropriate comet chart. The next object in the list, the globular in Aquarius, was plotted on the chart of Halley's comet, although it was not actually observed till 1760. The task of compiling such a catalogue did not begin in earnest until 1764, however. Within seven months Messier sought out 38 more entries for the list.



434 MÉMOIRES DE L'ACADÉMIE ROYALE

Vers $13^h 32'$, la Lune qui était couverte de nuages très épais, deux côtés de barrière le fait fermés, un en dessus, & l'autre en dessous de la Lune : celui qui était en dessus était plus sensible à la vue simple que celui qui était en dessus : les deux sommets étaient dans la même ligne, & perpendiculaire à l'horizon, comme on peut le voir dans la figure ci-jointe : ce phénomène a exilé l'espace de plusieurs minutes.

DES SCIENCES 435

CATALOGUE DES NÉBULEUSES ET DES AMAS D'ÉTOILES,

Que l'on découvre parmi les Étoiles fixes, sur l'horizon de Paris.

Observées à l'Observatoire de la Marine, avec différens instrumens.

PAR M. MESSIER.

PLUSIEURS Astronomes ont travaillé à la recherche des Etoiles nébuleuses, comme Hévelius, Huygens, Dechales, Halley, Cheseaux, l'Abbé de la Caille, & en dernier lieu M. le Gentil: d'autres Astronomes en ont découvert par hasard, soit en travaillant à la détermination du lieu des Etoiles pour en former des Catalogues, soit en observant le cours des Comètes : plusieurs de ces Astronomes n'ont fait que les indiquer dans les constellations où elles se trouvoient, sans en donner les positions exactes & une description détaillée. 16 Février 1771.

J'ai entrepris cet ouvrage en 1764, soit en observant celles qui étoient déjà connues, soit en en recherchant d'autres qui avoient échappé aux Astronomes depuis l'invention des lunettes : ce travail qui a été long & pénible me met en état de donner aujourd'hui à l'Académie un catalogue plus complet, plus précis & plus détaillé des Etoiles nébuleuses, ouvrage qui manquoit peut-être à l'Astronomie.

La Comète de 1758, le 28 Août, était entre les cornes du *Taureau*, je découvris au-dessus de la Corne méridionale, & à peu de distance de l'Etoile ζ de cette constellation, une lumière

IIII ij

The first page of Messier's paper describing his new catalogue of nebulae and clusters, from the history of the French Royal Academy of Sciences for 1771.

At the end of this period, in October, he made a thorough search for several nebulae reported earlier by Hevelius in his *Prodrome d'Astronomie*. Hevelius worked only with the naked eye, and most of his objects are no longer considered nebulous; Messier thus published as part of the memoir a number of objects previously reported, but which he could not find. In one case, however, he was not quite sure of the identification, so as the 40th and final listing from his 1764 efforts he included two small stars in Ursa Major, near the position given by Maupertuis in *Figure des Astres*. Messier was careful to note that there was no nebulosity there, and present-day astronomers have dropped M40 from the list.

In January of 1765, Messier by chance found the galactic cluster near Sirius (M41), but otherwise he made no systematic search, apparently. On March 4, 1769, he determined the positions of three well-known objects: the Orion nebula (M42 *and* M43), the Pleiades, and Praesepe, evidently adding these as "frosting" to bring the list to 45. Although Messier had independently discovered the majority of the objects, a large number, including the Crab nebula, had been found previously, a fact generally recorded by him in each instance. Nevertheless, this first list neglected several southern objects reported in 1755 by Lacaille and included in the extension of the Messier catalogue published several years later.

The initial list of 45 objects appeared in the *Histoire de l'Académie* for 1771, which was actually published in 1774. In the same year the catalogue was also printed in Lalande's *Ephémérides* for 1775-84. This first group of nebulae was the only part of the catalogue prepared for its own sake; most of the subsequent objects were found and reported in comet searches, so that the remainder of the catalogue is less systematic than the first part. There is no significant difference in limiting magnitude for the objects in the first group compared with the later observations, for Messier's in-

The first object in Messier's catalogue was the Crab nebula, in Taurus.

Another famous Messier object, M13, the globular cluster in Hercules. Photograph by Claude B. Carpenter.

A field of galactic or open clusters in Auriga, with M36 near the left edge and M38 in the upper center.

struments remained about the same.

These telescopes of Messier, a source of great curiosity to amateurs, make a puzzling historical problem, for in the memoir he follows the standard practice of the day in listing his instruments by length and magnifying power, instead of by aperture. The reflecting telescopes had inefficient speculum mirrors, adding further uncertainty to the amount of light-gathering power. Fortunately, however, Messier's friend Bailly used a number of these telescopes for a study of the satellites of Jupiter, and Bailly has given us invaluable information.

At one time or another, Messier used over a dozen telescopes, but none larger than his favorite, a 104-power Gregorian. This instrument had a length of 32 inches and an aperture of 7½ inches. Bailly computed that this was equivalent to a refractor about 28 feet long and with an effective aperture of about 3½ inches! Even less effective was an old 8-inch octagonal Newtonian, which had belonged to Delisle, and which was undoubtedly the original instrument at the Hôtel de Cluny. This was rarely used, for it was less efficient than a 2½-inch refractor. Messier frequently mentioned small simple refractors. Later he observed with several 3½-inch achromats, for at this time achromatic refractors were just coming into use. Those of Messier generally were 3½ feet long, with a magnifying power of about 120.

Messier voluntarily chose the smaller instruments, whereas Herschel, only a little later, exploited large reflectors. Messier's choice naturally arose from his interest in comets; Herschel, however, was able to resolve over a score of clusters which appeared merely nebulous to Messier. As an admirer of

(Continued on page 265)

NEWS NOTES

By Dorrit Hoffleit

SELECTED NAVIGATION STARS

In *Navigation* for March, Comdr. Edwin A. Beito, USNR, of the U. S. Naval Academy, discusses the revised list of 57 navigation stars used in the current *Nautical Almanac* and *Air Almanac*. Several substitutions have been made in the list, Polaris has been omitted (although data for it is given on a separate page), and the spellings of several names, such as Betelgeuse, have been changed. Concerning this, Comdr. Beito says:

"Betelgeux is changed to Betelgeuse, El Nath to Elnath, Etamin to Eltanin, Marfak to Mirfak, Rasalague to Rasalhague and Al Suhail to Suhail. Alpha Tri. Aust., Epsilon Argus, Gamma Crucis and Theta Centauri have been assigned the names, Atria, Avior, Gacrux, and Menkent, respectively. Deneb Kaitos has been changed to the more acceptable name, Diphda."

CONSTANCY OF COSMIC RAYS

Cosmic rays smashing into nitrogen atoms of the atmosphere change some of them into the isotope of carbon of atomic weight 14, which is naturally radioactive with an average lifetime of about 8,000 years. On the assumption that these carbon 14 atoms become rapidly mixed with such compounds as carbon dioxide in the atmosphere, thence with the hydrocarbons of vegetation and in ocean sediments, the ages of archeological and geological samples may be measured to an accuracy of about 100 years. The assumption has been proven correct by the agreement of carbon 14 datings with those of recorded history for the past 4,000 years. And it has been shown that the intensity of cosmic rays reaching the earth has been essentially constant for 12,000 years, or back to the end of the last great glacial period.

Extension of this work backward to about the maximum of the last phase of the Wisconsin glaciation, some 30,000 to 40,000 years ago, is described by J. Laurence Kulp and Herbert L. Volchok, of the Lamont Geological Observatory, Columbia University, in the *Physical Review* for May 15th. They comment, "This span of recent earth history displays about one-half of the greatest mean annual temperature fluctuation since the Cambrian period (500,000,000 years ago). Thus if the cosmic-ray flux was constant in this interval, and if it is related in any way to the total energy received by the planet, the integrated cosmic-ray flux would appear to have remained constant over most of geologic time."

Analyses were made of layers of mud in deep-sea cores by two methods: carbon 14 and the decay of ionium (thorium 230). For the ionium ages, the radium concentration in homogeneous cores as a function of depth was obtained. For the carbon 14 ages, the carbon in the precipitated calcium carbonate of the same core was used. Their errors of measurement were large, because the samples were small, but this summer the work will be repeated with larger cores. The scientists conclude: ". . . it seems certain that the cosmic-ray flux has not varied by more than 10-20 percent over the last 35,000 years."

GEOPHYSICAL YEAR

The year 1957-58, when sunspot activity is expected to be at its next maximum, has been designated an International Geophysical Year, and world-wide observations are planned in astronomy, geophysics, meteorology, geography, and radio science. Similar international geophysical years were conducted in 1882-83 and 1932-33, but then observations were confined to polar regions, whereas the current plans are global in scope.

The program has been instigated by the International Council of Scientific Unions. A committee to plan the United States' part in the observations has been selected by the National Academy of Sciences and the National Research Council, with Dr. Joseph Kaplan, of the University of California at Los Angeles, as its chairman.

IN THE CURRENT JOURNALS

ASTRONOMERS REVISE ASTRONOMICAL DISTANCES, by George O. Abell, **Griffith Observer**, June, 1953. "It may be disconcerting to the layman that the astronomer, who can predict eclipses hundreds of years in the future to within a fraction of a minute, could make a mistake by a factor of two in determining the distances to the most important objects in the universe."

THE SCALE OF THE UNIVERSE, by Stewart Sharpless, **Leaflet** No. 290, Astronomical Society of the Pacific, June, 1953. "Only after we have data of the highest accuracy on the distances, spectra, and apparent magnitudes of extragalactic nebulae can we hope to interpret such mysteries as the law of red shifts."

A LARGER AND OLDER UNIVERSE, by George W. Gray, **Scientific American**, June, 1953. "It is a vaster universe, not because we have discovered more distant objects, but because the already known and charted galaxies and clusters of galaxies are more remote and more widely dispersed than we had supposed."

An experiment to illustrate the Doppler effect by means of a vibrating device and wire stylus in a dish of water.

SOME DEMONSTRATIONS FOR THE CLASSROOM

By William A. Calder, *Bradley Observatory*
Agnes Scott College

EDUCATIONAL GADGETRY takes appreciable time and even thought. Perhaps it is not a wise use of energy; apparently it is not often undertaken. The same effort spent along conventional lines might result in the discovery of a dust cloud hundreds of light-years in diameter. The trouble, in my case, is that a wide-awake class is far more interesting.

The Doppler Effect

A whole book could be written on the uses of the Doppler effect in astronomy, but it would soon become obsolete as new applications arise, such as radar observations of meteors, and galactic exploration by means of the 21-cm. radiation of hydrogen. The usual classroom demonstration of the Doppler principle (if any is given at all) consists of revolving a sound source of constant pitch and noting the "wows." This year as I put away the mouth-organ reed, I resolved that, whereas off-pitch bells and whistles have no place in astronomy, I would attempt visual exhibition of the change of wave length produced by motion of a source. The final result is unexpectedly simple, but the changing wave patterns are beautiful to behold.

The output of an audio oscillator is fed into a small loudspeaker hung by two strings like a swing. To the speaker is attached a wire stylus which dangles so that its tip is just submerged in a dish of water, shown in the lower center of the picture. Very tiny ripples are formed by the vibrating speaker, and the frequency is adjusted so that apparently standing waves are produced when the surface of the water is illuminated by the rapidly flickering light of a 2-watt neon bulb. A large simple lens of about half a meter focal length projects this light and causes the observer to see the tip of the wire against an orange background upon which the ripples appear very much like interference fringes. As the speaker is caused to swing back and forth with an amplitude of about an inch, the thickening up of the waves on the forward side is strikingly revealed.

The stroboscopic effect of ordinary fluorescent light can be used. In place of a loudspeaker and audio oscillator, any slightly vibrating device such as a small transformer or electric razor would be satisfactory.

Collegiate Cepheids

Artificial variable stars can do for variables what a celestial globe does for the real sky — teach in a short time what would take a long time to observe in nature. Action in the sky is often too slow or too mild, and weather is unreliable.

For a quick look at Cepheid variation, a box was constructed with five small windows of ground glass backed by layers of tracing cloth for extra diffusion. Lights were arranged so that in a dark room four of the windows appear somewhat like stars well distributed in magnitude. The central window represents the variable star, which is a white Christmas-tree bulb in its own light-tight housing. The bulb is run by a 16-volt transformer, and can be dimmed in nine discrete and reproducible steps by remote control. The magnitude sequence was calibrated by visual matching processes using photographic films whose densities were determined by photocell.

A fictitious light curve was worked out involving 24 separate observations. The class was taken into a dark attic containing the synthetic stars, and magnitude estimating (using the Argelander system) was conducted in the manner of an auction sale. Discussion was lively and arguments were often fervent, but a general consensus was quickly reached. After the completion of observations, the class returned to the lecture room where

(Continued on page 260)

Above: The appearance of the light box with the variable star, in the center of the configuration, shown at various brightnesses.

Below: The appearance of the balloon with the light inside, at different phases. Peak light comes at medium size on the way out, at Phase 2 starting from the left.

Dr. Everett Phelps, chairman of Wayne University's physics department, here is lecturing to a class in the planetarium chamber. Note the adjustable mounting of the Spitz projector. The normal seating is for 35 persons.

A Small Planetarium in Detroit

By Charles A. Lewis, *Wayne University*

SCRATCH the surface of any typical American community, and you'll find a latent interest in astronomy. And if equipment is lacking, community effort can often provide it. This has been illustrated in Detroit, which now has an active planetarium center utilized by many community organizations, and plans for larger facilities of the same type. Many groups have contributed to the past and present efforts, with Wayne University serving as a physical center and providing some of the advisory and working personnel.

As early as the 1890's, Detroit's interest in astronomy brought forth a number of public meetings on the subject. These continued for a long time, but no organized group was set up until 1931, when six interested persons met at the College of the City of Detroit and organized the Detroit Astronomical Society. One of the six, Dr. Everett Phelps, of the college staff, arranged for an on-campus meeting room. Headquarters of the society have remained there since; and the college was renamed Wayne's College of Liberal Arts.

About 15 years later, the society decided to give the university a Spitz planetarium projector. This was partly to show thanks for the housing facilities so long provided, and partly to stimulate community interest. Though much appreciated, however, the instrument could not be used extensively because no dome was available for projection.

At this point, the Detroit Navigators Club became interested in the project. Membership in this club is conditional upon the passing of a special course in celestial navigation offered by the Detroit Power Squadron, an organization of small-boat owners in the city. A Wayne staff member, the late Wendell Vreeland, enjoyed close contact with the Navigators Club members because of his volunteer work in this teaching program. At his suggestion, the club donated $700 to build a dome, which is located in the corner of a high-ceilinged room in Wayne's ROTC armory.

The hemispherical dome, 20 feet in diameter, was designed by a member of the Detroit Power Squadron in consultation with Wayne University. Curved girders forming the framework are covered with wire mesh, which was plastered and painted white. A plasterer's darby, curved to perfect roundness and revolved over the wet plaster from a supporting pole in the dome's center, produced a distortionless inner surface. On two sides the dome is supported by the walls of the room; on the other two it is suspended from the ceiling by rods.

The projector mounting, constructed by a member of the Navigators Club, permits lowering the projector so that it may be wheeled out of the room into an adjacent storage cabinet, as the room is used also as a regular ROTC classroom. Space is at a premium in the building.

Since its installation, the planetarium has been in frequent use by boy scout and cub scout troops, high school science classes and clubs, Wayne astronomy classes, and 400 to 500 students at the university who each semester elect a survey course in the physical sciences. Navigators Club candidates assemble periodically for lectures on navigational stars, and the Detroit Astronomical Society occasionally meets in the planetarium instead of in its usual quarters in the lecture room of a nearby campus building.

There is, as yet, no regular lecture schedule for the public. Rather, an effort is being made to accommodate groups on request. No admission is charged.

As for future plans, a committee of the Detroit Astronomical Society has a goal of 1½ million dollars for a large planetarium installation. The city plan commission has already earmarked a site in Detroit's Cultural Center, of which Wayne University itself is a part. Such a planetarium would doubtless draw upon the personnel resources of the university for astronomy lectures.

SOME DEMONSTRATIONS FOR THE CLASSROOM

(Continued from page 259)

the observations were plotted. To the surprise of everyone, including teacher, a realistic light curve grew on the blackboard. In one hour much had been accomplished.

Pulsating Stars

Cepheids have long been compared with pulsating rubber balloons. Perhaps this concept has been considered too simple to take time to demonstrate, and it would be except for the crucial matter of phase relations of light and volume of the star.

A yellow balloon was mounted with a 6-volt flashlight at its center. Using a compressed air line, pulsations were maintained by manipulations of a control with the left hand while light changes were executed by turning a rheostat with the right hand. With practice, correct phase relations could be imitated.

The amplitude may have been exaggerated, but in the dark room the goings-on of the star were far more impressive and enlightening than previous explanations using drawings of light and velocity curves. No attempt was made to simulate double waves (simultaneous compression and expansion waves), but this no doubt could be worked out using the operator's feet!

Ultraviolet spectra of bright N-type stars taken with the 72-inch reflector at Victoria by A. McKellar. In each case, a laboratory comparison spectrum (bright-line) is included above and below the star. The middle and lower spectra are relatively short exposures and show the strong over-all absorption beginning at about 4100 angstroms for both stars. The upper spectrum of Y Canum Venaticorum was taken with an exposure of many hours and a short-focus camera, revealing features farther into the ultraviolet (to the left). Photo courtesy Dominion Astrophysical Observatory.

FLAMING STARS

By Otto Struve, *Leuschner Observatory*
University of California

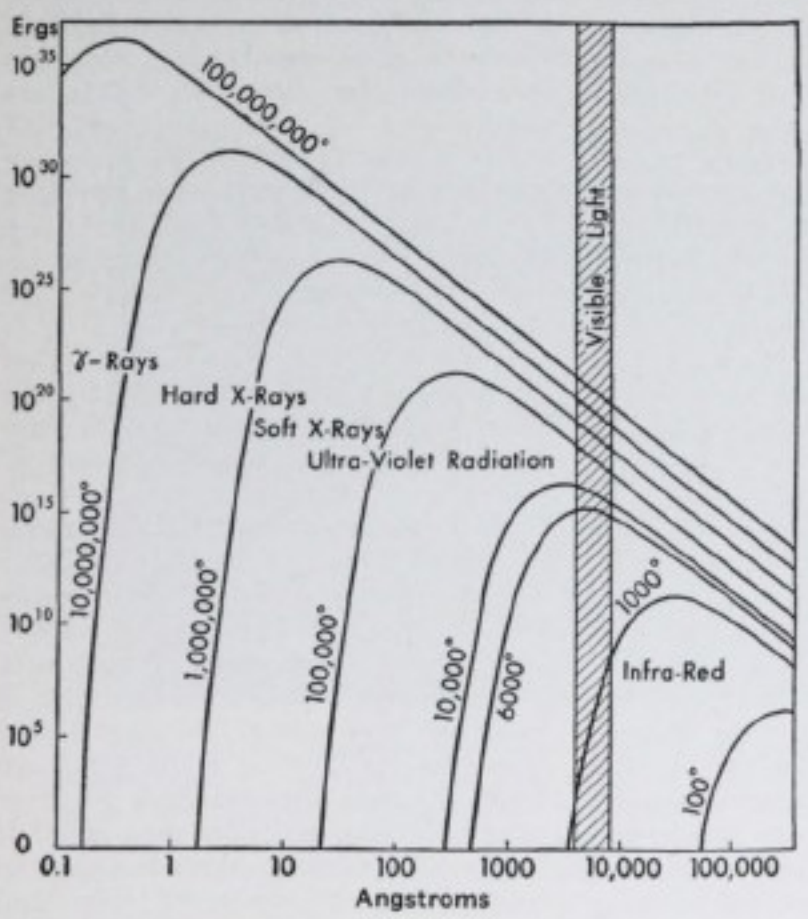
More than 30 years ago C. D. Shane discovered a remarkable absorption of light occurring in the atmospheres of the coolest *N*-type stars, which effectively blotted out all wave lengths in the violet region of the spectrum. With moderate spectroscopic dispersion these peculiar spectra were almost completely devoid of any light short of wave length 4300 angstroms. Hence, a direct application of the physical laws would have predicted surface temperatures of the order of a thousand degrees absolute.

One of these laws, namely, that first enunciated by the German physicist, W. Wien, states that the maximum intensity in the continuous spectrum of a radiating body occurs at a wave length in angstroms that is roughly equal to the number 30 million divided by the temperature. Since on Shane's spectra no light could be detected in the photographic violet region, it was reasonable to suppose that the maximum of the continuous radiation of an *N*-type star occurs somewhere in the infrared region, perhaps at a wave length of two microns or 20,000 angstroms. If we insert this value in Wien's law, we find for the temperature approximately 1,500°.

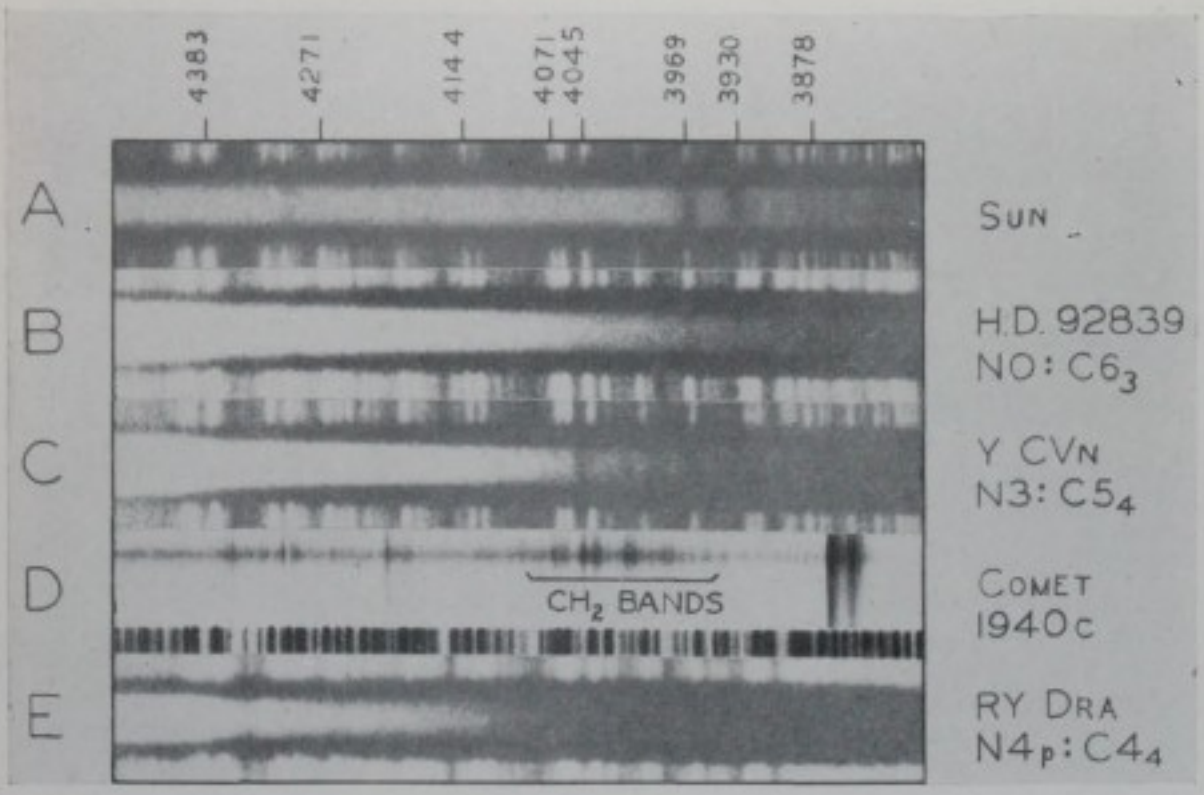
A more accurate determination of the temperature of a star may be obtained from the shape of the distribution of intensity all along the observed spectrum. This may then be compared with a set of theoretically computed curves derived from the radiation law of Max Planck. The result is of the same order of magnitude, but its derivation is far more reliable than the one that is based upon the estimated wave length of the maximum intensity. In the case of the *N*-type stars, the maximum intensity had not been observed by Shane, and it is only now becoming accessible to photographic observations with the help of the new and spectacularly sensitive plates made by Eastman Kodak and designated by the letter Z.

Both of these determinations rest upon the assumption that what we observe as the background continuous spectrum of the star represents essentially the light radiated by the star's photosphere. From the spectral lines in the *N*-type stars, Shane was able to conclude that the surface temperature of such a star is not as low as would have been predicted from the radiation laws. The inference, therefore, was that the continuous background of the spectrum does not register the true photospheric radiation, but is modified by gases and perhaps other substances above the photosphere which absorb most of the violet and ultraviolet light but transmit the blue, green, yellow, and red radiations. The lower spectrum of Y Canum Venaticorum and that of RY Draconis, in the illustration above, show how strong the violet absorption is in the atmospheres of these stars.

Later work, especially by G. A. Shajn and the writer at the McDonald Observatory, confirmed Shane's conclusion and showed that the absorption in the violet of the *N*-type stars is not entirely uniform. It is selective in the sense that in some wave lengths nearly all of the photospheric light is blocked out by the interfering material while in other, relatively narrow, parts of the spectrum the absorption is not particularly strong, so that some light escapes through the murky medium and reaches the observer, forming on the spectrum plates narrow spaces that at first sight resemble emission lines. In the upper spectrum for Y Canum Venaticorum, these "emission" features stand out strongly at the five points labeled alongside the words "spaces between absorp-



These black-body energy curves, plotted by Duncan on logarithmic scales for both energy and wave length, show the radiation of the coolest stars to be chiefly in the infrared region. The maximum radiation for the sun, at about 6,000°, is in the visible region, but much of its energy is released at wave lengths far shorter than those visible to the eye. Reproduced from "Astronomy," by John C. Duncan, published by Harper & Bros.



Short-focus ultraviolet spectrograms taken at the Dominion Astrophysical Observatory, except for Comet 1940c, which is from the McDonald Observatory. The star spectra are grossly overexposed at longer wave lengths (to the left). Compare the 4050 emission feature of Comet 1940c (here ascribed to CH_2) with the same region in absorption for the star Y Canum Venaticorum. Engraving courtesy "The Astrophysical Journal," University of Chicago Press.

tions" at the bottom of the illustration.

In fact, when Shajn and I discovered this effect, we were tempted to attribute the narrow spaces of emission to the radiation of discrete wave lengths by atoms and molecules in the atmospheres of the *N*-type stars. However, when the narrow emissions had been measured it was found that their wave lengths did not correspond to any known emission lines, and our final conclusion was that they represented portions of the continuous spectrum of the stellar photosphere that were passing through the absorbing medium relatively unimpeded. Hence, we not only found that the absence of violet and ultraviolet in the *N*-type spectra is caused by an overlying absorption spectrum, but we felt certain that at least a part of this absorption was irregular in character, resembling that produced by different kinds of molecules and not resembling the smooth absorption by dust particles of the kind that redden the light of distant stars in the Milky Way.

Still further advances in the study of the violet and ultraviolet absorption, by A. McKellar and P. Swings, led to the recognition of a strong absorption feature in the vicinity of λ4050 angstroms. This feature blocked out nearly all the photospheric light of the underlying star within a region approximately 100 angstroms wide, and was particularly noticeable on McDonald Observatory spectrograms of Y Canum Venaticorum, RY Draconis, U Hydrae, and X Cancri. Very long exposures of the spectra of these stars, made by McKellar at Victoria and by Swings at McDonald, show that even this strong absorption feature is not uniform over the entire 100 angstroms, and reveal regions of greater or of lesser absorption, which confirmed the conclusion that it is mainly produced by some molecule in the outer atmospheres of these stars. In the upper spectrum on page 261, the 4050 feature extends violetward to the "spaces between absorptions" feature at wave length 4009.6; at 4053 and 4020 it is particularly strong.

One of Swings' spectrograms of Y Canum Venaticorum, with relatively small dispersion and with an exposure of many hours, revealed the presence of a weak background of continuous emission extending into the ultraviolet region of the spectrum as far as λ3300. It should be realized that only 10 or 15 years ago astronomical spectrographs were completely opaque to the light of these invisible ultraviolet radiations because the ordinary glasses used in the construction of prisms, collimators, and camera lenses transmitted no light of wave length shorter than about 3600 angstrom units. Moreover, the silver coatings of reflecting telescopes were inefficient in ultraviolet light, and it was only after the technique of aluminizing astronomical mirrors came into use in the early '30's that this limitation was removed.

The McDonald Observatory spectrographs were the first that were designed especially to venture into the invisible ultraviolet part of the spectrum as far as the atmosphere of the earth will permit — to approximately 3000 angstroms. This was accomplished by means of mirrors for the camera and ultraviolet-transmitting glasses and quartz for the prisms and the collimator lenses.

With the help of one of these McDonald spectrographs, Swings found that the λ4050 absorption is only one of several bands, the others being located approximately at wave lengths 3790, 3700, 3595, 3480, and 3418 angstroms. These bands had never before been observed and they occur only in the *N*-type stars (frequently designated as carbon stars), and they are not present in the more usual *M*-type stars of low temperature, for example, Betelgeuse and Mira Ceti. Not a single one of these bands can be ascribed to a known molecule of a simple structure and consisting of two atoms. Most of the two-atom or diatomic molecules have been analyzed in physical laboratories and their spectra are well known. Swings concluded that the absorbing molecules in *N*-type stars cannot be diatomic in structure and must be more complex, consisting at least of three atoms.

Swings also concluded, after he had studied these individual absorption bands, that they were not sufficient to explain completely the extraordinary weakness of the continuous spectrum of the *N*-type stars. He suggested that, in addition to the discrete absorption bands produced by the known molecules, there is a superposed continuous absorption which extends all the way from the 3300-angstrom end of the observed spectral region to about wave length 4400 angstroms. This uniform absorption feature is of a novel kind. It does not resemble the absorption produced by molecules, since the latter appear in the form of distinct groups of closely spaced lines that may merge together, forming a dark space in the continuous spectrum of the star. However, the spaces between such discrete molecular absorption bands are usually free of absorption, and we should expect therefore that the space between the λ4050 band and the next band at λ3790 would be essentially free of absorption and would register an intensity consistent with Planck's law computed for about 3,000°.

It is partly with the identification of the new molecular bands and with the long-range absorption feature of wave length shorter than λ4400 that Swings' efforts are concerned.

Perhaps the most remarkable result of the work by Swings and McKellar was the discovery that the *N*-type absorption band at λ4050 agrees closely with a well-known emission feature in the spectra of comets. The latter is sometimes very strong, and it must have been observed a great many years ago when the first attempts were made to record photographically the light of bright comets. Since there has been no conclusive identification of this band

with any known substance on the earth, the cometary band has not been given a name.

It has become customary, however, to designate various molecular bands by the name of the person who has discovered them or who has succeeded in identifying them with a laboratory molecule. Because of the enormous amount of work which Professor Swings has done to advance our knowledge of the λ4050 feature, and also because it is certain that this particular band will play an important role in astrophysics during the coming years, I think it appropriate to designate it in this article as the *Swings band*. Although we are not yet quite certain as to the exact nature of the molecule that produces this feature, the work of Swings, McKellar, G. Herzberg, and A. E. Douglas has brought us to the point where we can expect any day to have a solution of this baffling problem.

Only two years ago, N. T. Bobrovnikoff wrote as follows in his chapter on comets in the volume on *Astrophysics*, edited by J. A. Hynek:

"The strong nuclear bands in the region around λ4050 long remained unidentified until in 1942 Herzberg gave reason to ascribe them to CH_2. Since no analysis of the rotational structure of bands has been made, and under the laboratory conditions other molecules consisting of C and H, such as CH_3 or even CH_4, might be responsible for the bands, this identification cannot be considered final.

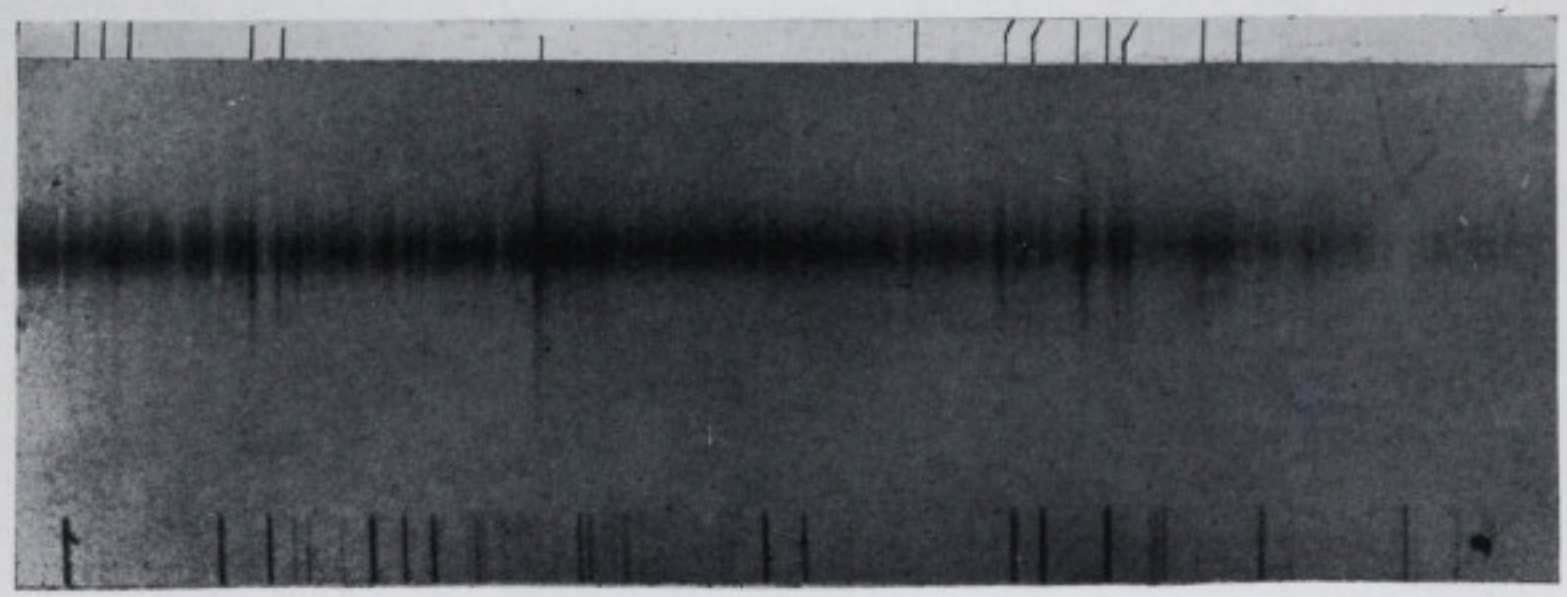
"There are some observational facts which speak against the molecule in question being CH_2. Such are the absence of a correlation between the strength of CH and CH_2, as well as between the heliocentric distance and the strength of CH_2, and frequent variations in the relative intensities of the members of this group. These bands more than any others show the variation in intensity in different comets regardless of the heliocentric distance. They were absent in the spectrum of Comet 1908 III (Morehouse) observed from r = 1.67 to 1.02, but in Comet 1927 VII (Pons-Winnecke), observed at r = 1.06, they were stronger than the CN and C_2 bands."

As Bobrovnikoff has pointed out, this feature appears in emission in the nucleus of a comet and it is not observed in the tail. Swings has noticed that its intensity in the spectrum of a distant comet is relatively great when compared to the identified comet emissions of CN (cyanogen), CH, C_2, OH, and NH. For example, when a comet is at a distance from the sun comparable to that of an average minor planet, the Swings band may be very strong while the bands of CH and C_2 are invisible. Swings also noticed that as a comet approaches the sun the identified emissions of cyanogen increase rapidly in intensity, while the Swings band increases slowly. There is also a difference in the extent of space surrounding the center of a comet head to which the Swings band extends, as compared to cyanogen, CH, and the like. Most of the latter bands are excited by the sun's radiation. The Swings band must result from the action of another process.

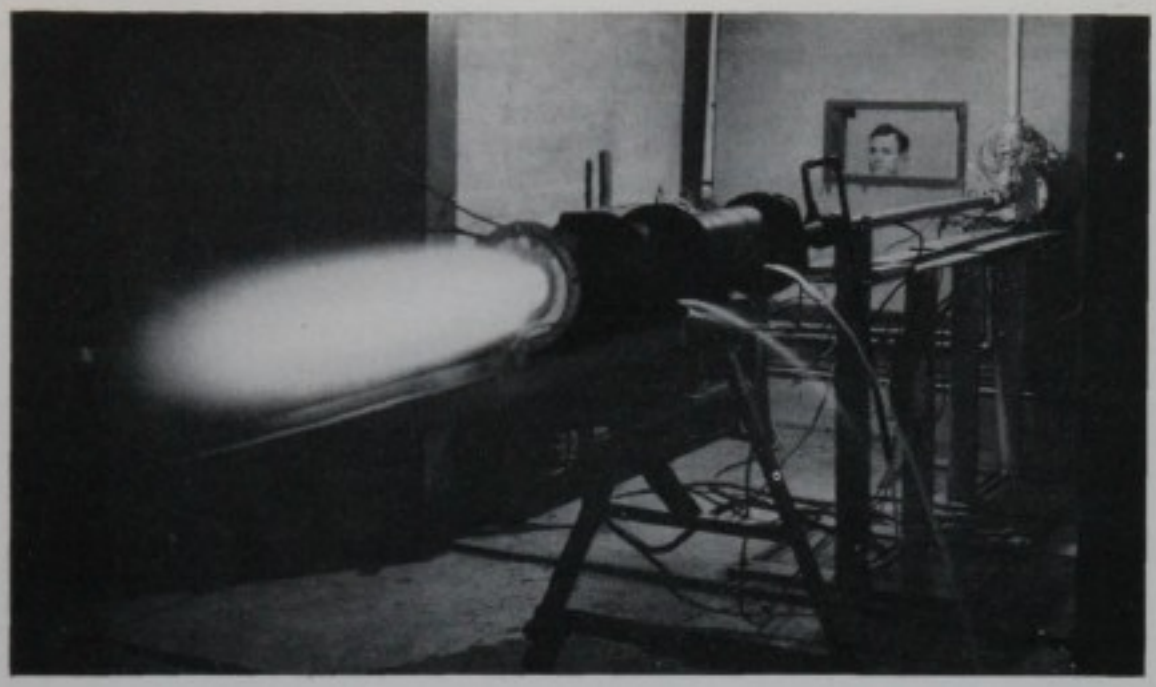
We have already seen that no diatomic molecule produces a band centered at λ4050. Hence it is reasonable to suppose that in comets, as well as in the stars, this band is produced by a polyatomic molecule consisting of at least three individual atoms.

Many years ago H. N. Russell pointed out that water vapor should be abundant in the cooler stars. Because of the very large preponderance of hydrogen in the atmospheres of most stars, molecules containing hydrogen are much more likely to occur than molecules that are composed entirely of other atoms. Hence, we were led to believe that the Swings band might contain hydrogen, and this probably induced Herzberg to attribute it to the molecule of CH_2. In a laboratory discharge, produced in a glass tube containing methane, CH_4, a band appeared at the required wave length, and Herzberg felt certain that it was caused not by methane molecules but by a product of the decomposition of methane, perhaps CH_2 or CH_3. It appeared at first that the CH_2 radicals could result in the laboratory experiment from the decomposition of CH_4 produced by the shock of the electrical discharge. In comets a process of photodissociation of methane might result also in the temporary formation of CH_2. Methane is a stable molecule and is present as an occluded gas in meteorites and terrestrial rocks. Moreover, the diatomic molecule of CH had already been identified in comets, as well as in the stars, and could be regarded as a further decomposition product of CH_2 from photodissociation by the radiation of the sun or a star.

However, soon after Herzberg's laboratory results were published, B. Rosen developed at the Astrophysical Institute in Liége a new method of observing the Swings band with great intensity. A cylinder of graphite was used as one terminal of the electric discharge and was placed in a glass cylinder containing pure hydrogen. After a spectrum of the Swings band had been recorded in the light of this discharge, the ordinary hydrogen was replaced with heavy hydrogen — deuterium — in order to see whether a Swings band would re-



A portion of the spectrum of Comet 1948l, taken at the McDonald Observatory by P. D. Jose and P. Swings. The strong central spectrum is that of the sun, reflected from solid particles in the comet's nucleus; this is a negative print, so the solar absorption lines appear light. The discrete emission lines of gases in the head of the comet are dark, and extend to various distances on either side of the nucleus. For instance, the 4050 group is not seen as far from the nucleus as the CN band at 4216 angstroms. Compare this spectrum with that of Comet 1940c on the preceding page; in both instances, violet is toward the right. Engraving courtesy "The Astrophysical Journal," University of Chicago Press.



This high-speed chemical plant, developed by James W. Mullen, II, E. J. Wilson, Jr., and J. B. Fenn, of Experiment Incorporated, operates on the principle of the ram-jet engine. As the diagram below shows, at various places in the combustion tube striking molecular changes take place. These may resemble the processes that produce triatomic carbon in the N-type stars. The water streams are from the quenching jackets that permit drawing off chemicals at various points along the tube. Photograph courtesy "Scientific American."

sult composed of one atom of carbon and two atoms of deuterium. Such a band would resemble the normal Swings band, but would be displaced in wave length by a small amount susceptible to measurement. The result was an intense photograph of the undisplaced Swings band, produced by precisely the same molecule that was first observed when ordinary hydrogen was used in the cylinder. This proved conclusively that the Swings band does not contain hydrogen. Swings and Rosen made a rough analysis of the band, based upon wave length measurements of a high resolution spectrum. This also indicated that the molecule was not CH_2.

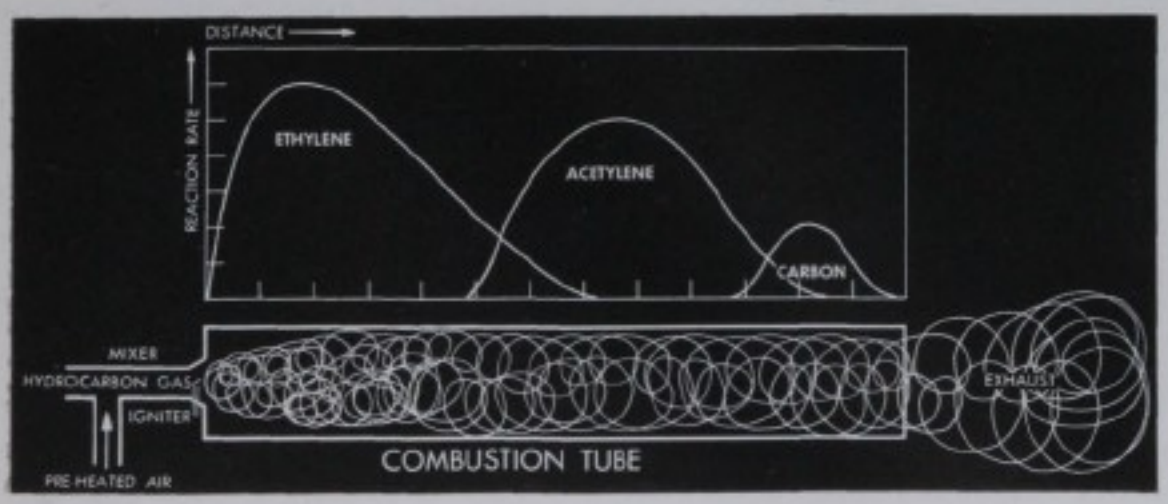
Swings next attempted to attribute the new bands observed by him in Y Canum Venaticorum to the same unknown molecule which is responsible for the Swings band. The analysis of different bands, each resulting from a different state of vibration of the molecule, is a complicated but by now a fully routinized procedure in spectroscopy. Although no conclusive identification could be obtained in this way (new bands beginning with λ3790 and extending to the ultraviolet, and possibly including a band at λ4352 observed by R. F. Sanford in the stars, have never been produced in the laboratory), Swings thought that the best guess would be the triatomic carbon molecule C_3, for which he has suggested the name *carbozone*, to correspond with the word ozone used to describe the triatomic molecule O_3. This identification is not final and it, of course, runs contrary to our desire to attribute molecules in stars, though not necessarily in comets, to some form of combination involving hydrogen.

The fact that a piece of carbon in the electrical discharge within an atmosphere of hydrogen, of deuterium, or of a combination of hydrogen and deuterium, produces the Swings band suggests that hydrogen is needed in the process but does not become a constituent of the resulting molecule. When an organic compound such as methane (CH_4), benzene (C_6H_6), or toluene (C_6H_5-CH_3) is circulated around the spark, the Swings band always appears, and it is often accompanied by visible sparks of light produced by incandescent solid carbon particles and by the resulting formation of soot. Again hydrogen is present in these organic compounds and is evidently needed for the production of the molecule that gives rise to the Swings band, but it is not in itself a constituent of the molecule. The latter apparently consists only of carbon and is an intermediate process in the ultimate formation of the solid carbon soot.

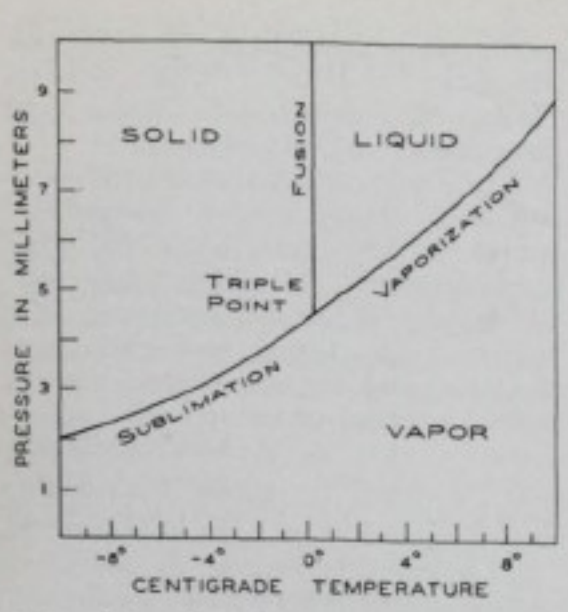
Last year R. A. Durie found the Swings band in a flame produced when fluorine was made to react with one of the organic compounds. Again a considerable amount of soot resulted, and there was also evidence of emission by C_2 and CH.

Although the formation of soot has great industrial importance, very little is known about the intermediate processes which accompany the burning of hydrocarbon gas. All of the thousands of molecules containing hydrogen and carbon are described as hydrocarbons. When such a gas is propelled rapidly into a combustion tube and is being ignited at one end, some of the intermediate molecules can be drawn off through suitable apertures placed along the length of the tube. Ordinarily, ethylene (C_2H_4) appears first; next there is a large concentration of acetylene (C_2H_2), and finally there is solid carbon in the form of soot. Quite probably the molecule of C_3 is formed somewhere between the acetylene and the solid carbon; in fact, it may be the beginning of the condensation of solid particles, consisting of a large number of carbon atoms. Actually, G. Porter has discovered that some 10 per cent of hydrogen can often be found mixed with the final sooty layer, and this suggests that the solid carbon results from the decomposition of some such substance as C_2H_2.

All of these results, incomplete as they are, strongly suggest that the Swings band in *N*-type stars represents an intermediate product between a stable hydrocarbon gas, for example, ordinary CH, and a cloud of solid carbon particles. The latter would be immensely more effective in producing continuous absorption of starlight than the original hydrocarbon gas. In this connection, it is of interest to recall the many suggestions that have been advanced in former years to explain the very large variations in the brightnesses of certain cool variable stars, such as



The chemical processes of the chemical plant seen in action above are shown schematically here. Rights to the process are owned by Chemical Construction Corporation. Diagram courtesy "Scientific American."



The triple-point diagram of water, showing the conditions of temperature and pressure under which transformations between the three physical states occur.

Mira Ceti and R Coronae Borealis. The latter star in particular has been investigated by J. A. O'Keefe, who computed from simple physicochemical considerations that the condensation of carbon particles out of atomic carbon gas would occur at a reasonable distance above the surface of R Coronae Borealis and would then fully account for a variation in the brightness of this star amounting to eight stellar magnitudes, or a factor of 1,500 in the light intensity.

For a simple substance, such as water, the vapor pressure can be measured as a function of the temperature. It is then found that for certain pairs of values of the pressure and the temperature the solid state and the gaseous state are in equilibrium. We describe evaporation from a solid substance as sublimation, and in the case of water this happens when the temperature is less than zero centigrade and the pressure less than about four millimeters of mercury.

It is possible to draw a curve which shows the pressure of the saturated gas in terms of its temperature. This saturation vapor pressure curve easily permits us to determine whether a gas will or will not condense into solid particles. Although the determination of this curve for water is an easy task, it is much more difficult for carbon or one of the hydrocarbon compounds. The best information concerning sublimation of graphite, which is solid carbon, was published in 1948 by L. Brewer, P. W. Gillis, and F. A. Jenkins. Their laboratory work resulted in a vapor pressure curve for the sublimation of C_3 gas, while three curves based upon slightly different starting data were drawn for the sublimation of atomic carbon gas. These latter curves are not entirely consistent with the earlier data used by O'Keefe, but a rough computation by Helen Pillans at Berkeley indicates that for a pressure of about 10^{-12} atmospheres and a temperature of about 2,000° atomic carbon vapor may be expected to condense into small particles of soot. In obtaining this estimate, Miss Pillans has used recent observational data by G. Herbig concerning the size of R Coronae Borealis and its luminosity.

Although this result differs appreciably from O'Keefe's, the main conclusion remains the same: There is every reason to believe that if a cloud of carbon gas should be shot out of the atmosphere of R Coronae Borealis, it would quickly attain a temperature and pressure so low that it could condense into soot. It would then act as a powerful absorber of starlight, fully accounting for the strange and irregular decrease in the brightness of this variable. As the cloud of soot would gradually disperse into space, it would become more transparent; and unless a new formation of soot were to follow immediately, the star would again appear of normal brightness.

The details of this transformation of carbon gas into soot are not fully understood, but it is probable that they resemble the processes in a flame of hydrocarbon gas, producing intermediate molecules and depositing at the end of the sequence a layer of solid carbon particles. We can therefore liken the processes in the carbon stars to the phenomenon of pyrolysis, that is, to the chemical decomposition of a molecular gas by the action of heat. Although oxygen is not involved in the stars, and there is no burning in the sense of oxidation, we can quite reasonably speak of R Coronae Borealis, Y Canum Venaticorum, and other such objects, as "flaming stars."

Comments From Readers

Dr. M. Minnaert, of Utrecht, Holland, writes in connection with the article on pulsating stars and underwater gas bubbles (March issue, page 119):

"It may interest you that some years ago I explained in the same way the sounds of water bubbles and that I made some measurements which confirm this explanation. . . . As in the case of the underwater explosion, the vibrating mass is the surrounding water. These two cases are, as far as I know, the only laboratory models in which gaseous spheres are found to pulsate. It is a pity that there are no other simple examples."

Professor Minnaert's paper on this subject was printed in the *Philosophical Magazine and Journal of Science,* Series VII, *16*, 235, 1933.

Dr. E. Heckscher, of Berlin, Germany, calls attention to a typographical error in the article on the chemical elements (April issue, page 154, center column). The remaining fraction of technetium after two million years should be less than 1/10,000, and not less than 1/10, as was stated. O.S.

MESSIER AND HIS CATALOGUE

(Continued from page 258)

Messier's list, Herschel carefully avoided giving his own numbers to any object catalogued by the Frenchman.

Three nights after Messier had presented his first memoir to the academy (on February 19, 1771), he recorded the positions of four more clusters. These were the first of 23 nebulae which were to be published in 1780 as an addition to the list. Of the four, two have proved to be a mystery to succeeding astronomers. By a sequence of copying Messier's original positions, M47 eventually received an NGC number (see *Sky and Telescope* for March, 1953, page 142); M48 did not even rate that, though both objects are frequently listed in current catalogues of the Messier objects. Both locations are in a region of rich star fields, yet Messier's precise positions fall in relatively blank areas.

Within the next few years, half a dozen more objects were found, mostly while he was observing comets, and these were indicated on the beautifully engraved charts accompanying these comet memoirs. The discovery of an object in Coma Berenices was specifically chronicled before the others, in connection with a memoir on an unusual aurora borealis in 1777. In the catalogue, however, it appears in order of discovery as M53. Several months later Messier finally located an object in Sagittarius, previously reported by Lacaille, but which Messier had been unable to find in 1764, and which was then reported in his list of nebulae not found. This became the 55th entry.

Beginning in 1779, Messier observed nine more objects in connection with the comet of that year. This comet passed across the Coma-Virgo region of galaxies, bringing about the first discoveries in that area. In the following year, by chance he discovered the 65th and 66th objects, a pair of galaxies in Leo. In 1773 a comet had passed between them, but Messier failed to note their presence because of the light of the comet.

In April of 1780, Messier made the final two observations to bring the list up to 68 in time for the deadline of the French almanac, *Connaissance des Temps,* for 1781. In this volume, consisting mostly of tables, the objects were listed with positions, and the date when each position was determined, and on the facing page a brief description was included. The editors noted, "In addition to the catalogue published by Messier, which we give here, we report further a large number of nebulae and clusters which he has discovered since the printing of the memoir, and which he has communicated to us."

(To be continued)

Amateur Astronomers

Mid-States and Southwest Regions Hold Conventions

THE fourth annual convention of the Mid-States region of the Astronomical League was held June 12-14 at Lake of the Cherokees near Grove, Okla. Our host was S. S. Whitehead, of the Wichita Astronomical Society, and convention details were handled by John A. Stewart and Robert L. Frossard, of the Tulsa Astronomical Society.

Delegates arrived Friday night for a get-together and star party. The skies were exceptionally bright — as even local residents commented. Some of the delegates stayed in cottages near the lake, some in the New Grove Hotel, but the hardy souls took advantage of the special camping-out facilities.

The Saturday conclave was held on the wooded slope near the lake adjacent to Whitehead Lodge. Papers given at the morning session included "The Observation of Star Color and Its Value to the Observer," Stuart L. O'Byrne, St. Louis; "A Plea for Co-operative Observations of Lunar Flares," Robert M. Adams, Neosho, Mo.; "The Missing Messier Nebulae," Walter Scott Houston, St. Charles, Mo.; "Application of Electronics to Amateur Astronomy," J. A. Westphal, Tulsa; "Opportunities in Meteoric Astronomy; Study of Shadow Casting Meteors; Watching for Meteorites when Plowing or Hunting," Dr. C. C. Wylie, State University of Iowa.

Meteorites and eclipses were discussed at the Saturday afternoon session, highlighted by talks by Edwin E. Friton, St. Louis regional director, American Meteor Society, and Dr. Edward M. Brooks, St. Louis University. Kodachromes of the 1951 annular eclipse, taken by John Reed, Central Missouri Amateur Astronomers, were shown in conjunction with Dr. Brooks' paper on weather expectations for the total eclipse next June.

New regional officers are Mr. O'Byrne, chairman; Mr. Adams, vice-chairman; John A. Stewart, Tulsa, secretary-treasurer. Joseph A. Smith, Kansas City A. C., was appointed to plan a regional news bulletin. Efforts were made to complete plans for co-operative observing programs.

The 60 members and guests who attended the annual banquet Saturday evening heard Dr. Balfour S. Whitney, of Oklahoma University, present a talk on "Small Observatories." He discussed the use of large and smaller telescopes to yield astronomical information. Dr. Whitney has done most of his variable star work with a small instrument, and he challenged amateur astronomers to "prove" our small but adequate observatories with an observing program.

A vote of thanks was given the outgoing officers under whose guidance the Mid-States region was formed and has grown to its present stage. After adjournment, we retired to the lake shore to see the new Yerkes Observatory film, Aurora Display, taken with the modified Greenstein-Henyey wide-angle camera, and shown by Dan Schulte, of Yerkes Observatory and Enid, Okla. Color slides of Yerkes were also shown. The rest of the evening was spent in observing, the largest telescope on hand being the 12-inch Newtonian of the Tulsa group. Shop talk carried over into the wee hours and continued Sunday morning as the delegates slowly dispersed to their respective states.

John W. Reed
1802 Paris Rd.
Columbia, Mo.

ON June 19-20, the Southwest region of the Astronomical League held its first convention, at Texas Christian University in Ft. Worth. Everyone attending felt that the region, formed only last July at the general convention in Dallas, has made a great deal of progress in the advancement of amateur astronomy.

The featured speaker was Dr. J. H. Rush, of the High Altitude Observatory, Boulder, Colo., who spoke on solar-terrestrial relations, with the subtitle, "Today's Sunshine — Tomorrow's Weather," for press notices of this public meeting.

Among the more outstanding papers, one by Ted Gangl, of Dallas, presented the idea that the average amateur astronomer is tending to neglect the novice. Mr. Gangl gave many hints on how to aid the beginner in astronomy. A. W. Mount described methods of observing variable stars, a phase of the hobby much neglected in the Southwest. Two large meteorites, one weighing 258 pounds, were exhibited by Oscar Monnig, of Ft. Worth, who also showed a series of color slides that demonstrated the possibilities for the amateur in the field of stellar photography with small cameras.

A paper read for Walter Haas, regional representative and director of the Association of Lunar and Planetary Observers, pointed out the possibility of observing an aurora on Venus. Harrison Sarrafian, a Dallas junior astronomer, spoke on mathematical relations of star magnitudes, while two other Dallas juniors, Frank Jones and David Jones (not related) presented a "Trip Through the Seven Wonders of the Universe," complete with color slides and recorded sound effects.

A panel of experts Saturday night completed the program, with the experts including Dr. Rush; Dr. Marjorie Harrison, Ft. Worth; E. M. Brewer, Dallas; Mr. Monnig; Mr. Mount; and John Hulme, a Dallas chemist.

The Ft. Worth Astronomical Society was host. There were 90 persons registered, including 32 juniors, and other guests attended. Mr. Mount was elected regional chairman, succeeding Mr. Brewer. Mr. Gangl was made vice-chairman, and the undersigned was re-elected secretary-treasurer.

J. M. McMillen
604 Tierney Rd.
Ft. Worth, Tex.

NORTHWEST REGIONAL MEETING

The Amateur Telescope Makers of Spokane, Wash., have invited the Northwest region of the Astronomical League to hold its annual convention in Spokane on July 31-August 2, with sessions at the Rural Electrification Administration auditorium, East 320 Second Avenue. There will be a banquet on Saturday evening. Persons having papers to present or material to exhibit should contact George Mehaffey, West 2231 Providence Ave., Spokane. Advance registration, at $1.00 per person, is requested but not essential.

MARIN AMATEUR ASTRONOMERS

On Saturday evening, May 23rd, the Marin Amateur Astronomers met at the Mission Inn in San Rafael, Calif., for their annual banquet. Thomas S. West spoke on the great advances that might be possible in astronomy at that time in the future when man may commence observations of the heavens from the moon.

Dr. Edward C. Day, San Anselmo, president-elect, was presented with a 3-inch reflector made by four club members, John Treleven, Woodrow Wilson, Leslie Stokely, and Al Rinker, who also assist others in the group in their telescope making activities. The base and fork mounting were cast from scrap aluminum, and the tube is a heavy piece of salvaged aluminum tubing.

Other officers elected are Mr. West, Tamalpais Valley, vice-president, and Vincent S. Yoder, Mill Valley, secretary-treasurer. Kenneth Irwin, San Rafael, was appointed chairman to direct preparation of the society's participation in the widely known Marin Art and Garden Show in July.

VINCENT S. YODER
48 Mercury Ave.
Mill Valley, Calif.

MEMPHIS ASTRONOMY

The Memphis Astronomical Society, organized in December, 1952, is the only active amateur club in Memphis, Tenn. There are now 10 members, and the group meets every Friday. The club already has two 3-inch reflecting telescopes and a 6-inch, and construction of a 10-inch reflector has been started.

JON M. BUHLER
3796 Central Ave.
Memphis, Tenn.

LEAGUE CONVENTION PAPERS AND REGISTRATION LIST

BY LATE in June, Charles H. LeRoy, program chairman, had placed the following papers on the schedule of the general convention of the Astronomical League, to be held in Washington, D. C., September 4-7:

Observing session, Saturday afternoon. Solar Granulation — An Astronomical Headache, Dr. James C. Bartlett, AAVSO. The Uses of Visual Observations of the Aurora, Donald S. Kimball, AAVSO. The Markings of Jupiter, Frank Dachille, Pensacola Astronomy Club. The Visibility of the Venus Shadow Side, Lonzo Dove, ALPO. New Projects for Amateur Astronomers, Dr. Francis J. Heyden, S.J., Georgetown Observatory. Photoelectric Photometry for the Amateur, John J. Ruiz, AAVSO. Some Experiments in Lunar and Planetary Photography, Lyle T. Johnson, ALPO.

Junior session, Sunday afternoon. Papers for this session are being collected by Clarence E. Johnson, chairman of league junior activities. Among the speakers will be Jerry King, Ft. Worth, Tex., Philip Lichtman, Washington, D. C., and James Kaler, Albany, N. Y.

Radio astronomy session, Sunday afternoon. Solar Activity Patrol by Optical and Radio Astronomy Techniques, Alan H. Shapley, National Bureau of Standards. Galactic Studies by Radio Astronomy and Meteor Observations by Radar will be the titles of two other papers.

Instruments session, Monday morning. Discussion on Improvements to Amateur-built Instruments, Leo N. Schoenig, AAA of Pittsburgh. Building Photoelectric Photometer Equipment, Mr. Ruiz. Amateur-built Telescopes on the West Coast, Rolland R. LaPelle, president, Astronomical League.

"Operation Eclipse" session, Monday morning. Aspects of the Sky Along the Central Line, Paul W. Stevens, Rochester Academy of Science. The Weather Outlook for the 1954 Total Solar Eclipse, Dr. Edward M. Brooks, St. Louis University. Report on convention arrangements at Madison, Wis.

Other major papers will include: The Practical Value of a Small (Artificial) Satellite, Dr. John A. O'Keefe, Army Map Service; Living Matter in a Universe of Matter, Dr. Bartlett; The Small Planetarium in the Museum Program, Charles G. Wilder, Kansas City Museum (in absentia).

The tentative convention program was printed in the June issue. Further information, particularly concerning advance registration, may be obtained from Mrs. Ione Alston, 20 Plattsburg Court, N. W., Washington 16, D. C. As of June 17th, 162 persons had registered, representing 17 states, the District of Columbia, and Canada, as shown below:

CANADA: *Toronto*, Edwin V. Greenwood.

CONNECTICUT: *Mount Carmel*, William G. Cleaver. *New Haven*, Sara L. Furnald, Mr. and Mrs. Frank Velardi.

DISTRICT OF COLUMBIA: Mrs. Ione Alston, Mrs. Marian Ambleau, Nathan Apple, Jewell Boling, George Borresen, Thelma Cressy, Elanora B. Davis, Paul S. Davis, Samuel R. Friedman, Dr. James Q. Gant, Mrs. Dorothy Geare, Margaret B. Glock, Elizabeth Goerner, Agnes Hastings, Ruth F. Heisey, Paul Kanstoroom, Charles T. Kemmerer, Mrs. Merilyn Loria, U. S. Lyons, Nettie Mansker, Donald L. Miller, Mrs. Ernest Eden Norris, Sr., Ruth Parsons, William E. Pfeifer, Abraham Robinson, Mr. and Mrs. Morton Schiff, Selma Schmidt, Mabel Sterns, Lou Nell Sutherland.

FLORIDA: *Pensacola*, Frank Dachille. GEORGIA: *Atlanta*, C. H. Holton. *Decatur*, William A. Calder. *Griffin*, P. O. Parker. ILLINOIS: *Chicago*, Joseph A. Anderer. *Moline*, Mr. and Mrs. Carl H. Gamble. KENTUCKY: *Louisville*, Alan Krauss, Mr. and Mrs. Jesse L. Ralph, Mr. and Mrs. Charles Strull.

MARYLAND: *Bethesda*, Geraldine Windham, Mr. and Mrs. Ray K. Windham. *Bladensburg*, Estelle Isherwood, William L. Isherwood, Jr. *Chevy Chase*, Mr. and Mrs. Hoy Walls. *College Park*, William H. W. Komp, Dorothy E. Lamore. *Coral Hills*, J. M. Kendall. *Greenacres*, Leo Scott. *Kensington*, Ned Johnston, Irene Warthen. *La Plata*, Lyle Johnson. *Rockville*, Roger K. Smith. *Silver Spring*, John Lund, Grace Scholz, Mr. and Mrs. G. R. Wright. *Takoma Park*, Elizabeth Fazekas.

MASSACHUSETTS: *Belmont*, Mr. and Mrs. C. A. Federer, Jr. *Jamaica Plain*, Fred A. Pflug. *Lexington*, Mr. and Mrs. Chester Cook. *Milton*, Katharine H. Hendrie. *Worcester*, Ralph A. Wright. MICHIGAN: *Detroit*, Mrs. Olive Grunow, C. S. Johnson. *Pontiac*, George Carhart, Mrs. Mabel Chircop. MISSISSIPPI: *Vicksburg*, Mrs. Albert M. Bonelli. MISSOURI: *Overland*, Edward M. Brooks. *St. Joseph*, Jesse Moore. *Sedalia*, Russell C. Maag.

NEW YORK: *Bayside*, David Williams. *Brooklyn*, Florence Rosenblatt. *Buffalo*, Mr. and Mrs. Edward Lindsberg, Mr. and Mrs. Eugene Wallmeyer. *Elmhurst*, Herbert A. Luft. *Flushing*, Mr. and Mrs. Harry Bondy. *Great Kills*, James H. Rosenquist. *Long Island City*, Jane E. Burden. *Oceanside*, Mr. and Mrs. Theodore Zaph. *Rochester*, Mr. and Mrs. Paul W. Stevens. *Schenectady*, Gladys L. Carr, Clarence Johnson. *Scotia*, Dora E. Hayes. NORTH CAROLINA: *Greensboro*, Elizabeth Boyd. *Randleman*, Mrs. Carrie Boling.

PENNSYLVANIA: *Baden*, Mr. and Mrs. Thomas LuCaric. *Bryn Athyn*, Mrs. Robert M. Cole. *East Lansdowne*, Lawrence Maggitti. *Meadville*, Mr. and Mrs. Rolland LaPelle and son. *Milton*, Owen C. Ranck. *Philadelphia*, E. F. Bailey, John F. Farkner, John Streeter, Eleanor Vadala. *Pittsburgh*, Charles H. LeRoy, Mr. and Mrs. Leo N. Schoenig. *Upper Darby*, Jerry Burns. TEXAS: *Dallas*, E. T. Cramer. *Ft. Worth*, Dr. Gerald A. King, Jerry King, Jr.

VIRGINIA: *Alexandria*, Mr. and Mrs. Robert H. Dellar, Bobby Dellar, Kenneth J. Graham, Mr. and Mrs. William H. Hyde, Robert A. Jones. *Arlington*, Dr. H. S. Coffey, David Fetter, Dana Law, R. M. McLellan, Alexander L. White. *Fairfax*, Mr. and Mrs. James M. Cracroft. *Falls Church*, Paul Cico, Villard S. Griffin, Jr., Clyde A. Lofland, Mr. and Mrs. Ellis Marshall, R. A. Soucy. *Newport News*, Mr. and Mrs. R. J. Wicke. *Norfolk*, P. Nash Anderson, E. Causey, Miss I. E. Harden, A. D. Hustead, C. E. Jenkins, R. W. Sanderlin, Dr. J. S. Zabner. *Petersburg*, Rev. W. F. Elliott. *Richmond*, A. R. Anderson, Roy D. Montgomery, T. J. Ogburn, III, Beaufort S. Ragland, T. W. Stone.

WISCONSIN: *Milwaukee*, Mr. and Mrs. R. L. Dodd, Mr. and Mrs. Richard R. Fink. *Oshkosh*, Mr. and Mrs. Ralph N. Buckstaff.

D. F. MATHE DIES

On June 17th, D. F. Mathe died in Pittsburgh at the age of 48. Secretary of the Amateur Astronomers Association of Pittsburgh, Mr. Mathe was a commercial artist, and served recently as chairman of the Astronomical League emblem committee. He also designed the certificate used annually for the Astronomical League award.

LOS ANGELES CONVENTION

Among the special events scheduled for the fifth convention of Western Amateur Astronomers on August 14th to 16th will be a conducted tour of Mount Wilson Observatory, including the 100-inch telescope, and a talk on solar work in the Mount Wilson auditorium by Dr. Seth B. Nicholson. A star party will also be held on the mountain.

The convention will meet on the UCLA campus, where papers by professional and amateur astronomers will be heard. An innovation this year will be the organized "bull sessions," informal discussion groups with experts on hand, covering such phases of the amateur's hobby as mirrors, mounts, observing of the moon, planets, or variable stars. The banquet will feature a quiz session, with a panel of experts in various fields of astronomy to answer questions.

Detailed information on the convention and on where to stay may be requested of Mrs. George Carroll, 7114 Summitrose St., Tujunga, Calif. The registration fee for the convention is $2.00 per person.

THIS MONTH'S MEETINGS

Indianapolis, Ind.: Indiana Astronomical Society. August 2, observation meeting, Butler University.

Kalamazoo, Mich.: Kalamazoo Amateur Astronomical Association. August 15, pot luck supper at Wolf Lake. Jerome Korman, "The Universe and Mr. Einstein."

TRIPLE MEETING IN OCTOBER

The program for the convention of amateur instrument makers to be held October 11th and 12th at Harvard Observatory, Cambridge, Mass., includes a meeting of the Northeast region of the Astronomical League. A general announcement of the convention was made in the January issue, page 70. Registration (there will be a $1.00 registration fee) will begin at 10 o'clock on Saturday morning, October 10th, at Harvard Observatory in Cambridge, where all sessions will be held.

The annual meeting of the American Association of Variable Star Observers, opening on Friday evening, October 9th, will have sessions Saturday at the observatory, to which all interested amateurs are invited.

The instrument makers meeting will begin Sunday, October 11th, with a visit to Harvard's Agassiz station in Harvard, Mass., from 9:30 to 1 o'clock. At 2 o'clock the exhibit will open, with instrument makers standing by their exhibits for discussion and demonstration. A judges committee will review the exhibits. A session for papers will be held from 4 to 6 p.m., and from 7:30 on there will be observing sponsored by the Amateur Telescope Makers of Boston and the AAVSO.

The council of the Northeast region will meet on Monday morning (Columbus Day) at 10 o'clock, and the annual business meeting of the region is scheduled for 1:15 p.m. The convention will adjourn Monday at 6 p.m.

Further information can be obtained by addressing the Convention of Amateur Instrument Makers, Harvard College Observatory, Cambridge 38, Mass.

BOOKS AND THE SKY

THE NAMES OF THE STARS

E. J. Webb. James Nisbet & Co. Ltd., 22 Berners St., London W.1, England, 1952. 206 pages. 15s.

IF THE READER of this book (published posthumously) expects to find a learned and up-to-date discussion of the origin, meaning, and history of star names, as he has a right to expect from the title, he is doomed to disappointment. It is true that the author mentions a few names in a conventional manner, and discusses the constellations from his own peculiar point of view; but the first half of the book is merely window dressing for the second half, wherein he feverishly attempts to prove the nonexistence of the nonexistent. But let us take first things first.

He bitterly complains of the increasing quantity of "coal smoke," "artificial illumination," and "the stench of motor coaches. . . which the cupidity or stupidity of the times demands." He regrets bitterly the decreasing number of "stargazers," and wonders "if there be any who still survive." And the professional astronomer is not exempt from his acerbity. "One finds it assumed that a man who knows what goes on inside the stars must know equally well what the stars look like as they are seen peopling the sky." This, he says, "is very far indeed from being the case."

But let us see what he says about some of the star names. He translates the Arabic name of Orion, **al-Jauza'** (the **alif** before the **hamza** is long), as "bride," thus falling back on Schjellerup's illegitimate manipulation of the syllables of the word in order to change the meaning from that of "the white-belted sheep" to that of "the bride." His statement that **al-Jauza'** is a name "usually translated as 'The Bride'" is wholly false and proves his unfamiliarity with the Arabic language and the meaning of star names. His transliteration of the Arabic letter **jeem** is almost as bad as Ideler's, who, however, had no "j" sound in his language. In his discussion of Auriga, the author attempts to criticize others more learned than himself:

"In the Babylonian tablets . . . β and ζ (Tauri), to us the horns of the Bull, are called respectively the north and south **sur** of the **narkabti.** Now **narkabti** means a cart or chariot, and it is curious that the Assyriologists, who were pouncing on every chance of proving the descent of the Greek zodiac from the Chaldaeans, seem not to have noticed that they had here really come upon an apparent link between the two spheres. What **sur** means is apparently unknown. Kugler translates it as 'Bull'; but only, I think, in despair at finding no other trace of the name which the sign, according to him, ought to bear. R. Brown translates it as 'light', but even this critic's strange intuitive knowledge of ancient mentality cannot have taught him that the comparatively harmless vehicles of ancient times were compelled, or even accustomed, to carry lamps. Jeremias makes **sur** mean 'wheel', and he renders **narkabti** as **war**-chariot, in which case it seems unlikely that it would be drawn by oxen."

Webb's great mystery regarding the meaning of **sur** is easily solved when you know that it is a perfectly good Sumerian word meaning "the bright, or brilliant, one," and Brown's translation of it as "the light" needs only a bit of imagination to understand. To complete the record: β Tauri was called SUR **Narkabti sha iltanu,** "the northern brilliant one (i.e., star) of the chariot," and ζ Tauri, SUR **Narkabti sha shutu,** "the southern brilliant one of the chariot" (the macrons are omitted). Webb's argument, therefore, becomes ridiculous and falls of its own weight. Ignorance of Arabic and Sumerian can get a writer on star names into a peck of trouble.

Turning now to the constellations, we find that his discussion centers around one basic question: Do the stars really form the figures which are delineated in them and which they are supposed to represent? It would be useless to follow the author in this discussion, for it constitutes the worst case of **ex post facto** reasoning I have ever encountered. Ophiuchus "got his name because he seems to be holding a serpent"; Hercules was so called "because he appeared to kneel"; Cygnus "was known as a Bird surely because it looks like a bird, and the reason for making that Bird a Swan is because no bird so shaped is more beautiful"; Pegasus is called a horse because "it really does resemble the forepart of a horse . . . and that there is such a resemblance no one will contest." Webb could see without any difficulty the figures the constellations are supposed to represent because he was the stargazer **par excellence,** and could project himself backward in time thousands of years and see exactly what the ancients saw!

One valuable piece of research in connection with the constellation of Taurus should be mentioned. It has been assumed by all writers on the constellations that Virgil's words,

> **candidus auratis aperit cum cornibus annum Taurus . . .**

referred to the time when the vernal equinox fell in the constellation of Taurus. This, of course, is not true, as a translation of the complete sentence, which follows, will show.

"Spring is the sowing time for beans; then, too, the crumbling furrows receive you, Median clover, and the millet claims our yearly care, when the snow-white Bull with gilded horns opens (**aperit**) the year, and the Dog sets, retiring before his confronting star."

Webb shows, by references to Varro and Ovid, that April was regarded as the "opening month," and not March, for it was then that the leaves and flowers came out.

We may judge of Webb's astronomical knowledge by his emphatic statement that at least 20 stars have changed considerably in luminosity in the past 2,000 years; "of this there can be no doubt whatever."

Turning now to the second half of the book, we find that the substratum of astrological thought, which was cleverly concealed up to this point, comes to the surface without disguise. From here on we

Sky Publications

MAKING YOUR OWN TELESCOPE. by Allyn J. Thompson — This book gives complete instructions on how to make a 6-inch reflecting telescope **$4.00**

INSIGHT INTO ASTRONOMY. by Leo Mattersdorf — A book for the layman answering the questions the average person has on astronomy **$3.50**

SPLENDORS OF THE SKY — A 36-page booklet of astronomical pictures .. **$.50**

RELATIVITY AND ITS ASTRONOMICAL IMPLICATIONS. by Philipp Frank — The general theory of relativity discussed for the layman ..... **$.50**

SKY SETS I — 24 pictures of the solar system and galactic objects, each 8½ x 11¾ inches printed on heavy paper, with a white border. A separate sheet of captions is included **$3.50**

MOON SETS — 18 separate pictures from Lick Observatory negatives, each 9 x 12 on a sheet 12 x 18 inches. Small key charts are provided for the identification of lunar seas, mountains, and craters **$2.50**

ATLAS OF THE HEAVENS — 16 charts covering the entire sky, each 18 x 24 inches, make up the Skalnate Pleso **Atlas of the Heavens.** The charts show all stars to visual magnitude 7.75, including binary and multiple stars, and variables. All galaxies brighter than 13.0 are included, as well as clusters and nebulae, and Milky Way outlines **$5.50**

MAPPA COELESTIS NOVA — A map of the northern sky, 25 inches in diameter. Six colors are used to indicate the spectral types of all stars brighter than the 5th magnitude. The map shows the magnitude of each star, as well as the names of the brighter ones. A decorative display piece **$4.00**

WORLD-WIDE PLANISPHERE. by William H. Barton, Jr. — A book of basic constellation charts and masks to show the stars above the horizon at any time of night or year, at all latitudes, northern and southern **$3.00**

THE NATURE OF COSMIC RAYS. by W. F. G. Swann — An introduction to the problems confronting scientists who seek to determine the nature and origin of the most energetic particles that reach our earth from space ..... **$.50**

Payment should accompany your order; stamps accepted.

Sky Publishing Corporation Harvard College Observatory Cambridge 38, Massachusetts

read only of the **signs** of the zodiac, in fact, they are mentioned 160 times; and we get unmistakable evidence of the author's real background when he says that "the leading principle of astronomy" is "the belief that men's fates are ruled by, and may be read in, the stars." He seeks to show that, since the word **zodiac** came into existence during the lifetime of Aristotle, and that it was about that time divided into 12 equal portions called **signs,** there was never a time when the vernal equinox fell in the sign of Taurus, because the signs came into existence when the vernal equinox fell in the sign of Aries. Cuneiform tablets would be anathema to him, because the ancient Sumerians, who were not astrologers, never referred to the **signs** of the zodiac! They called that portion of the sky KAS UTU, "the Way of the Sun." Hence, as I said at the beginning of this review, the author seeks to prove the nonexistence of something which could not have existed 2,000 years before the word itself came into being!

Not being an astrologer, I am not competent to judge of the value of this book as a contribution to astrology. It is certainly not a contribution to the study of star names. The finest part of the volume consists in the notes by Ivor Bulmer-Thomas. They are apposite and scholarly, and never astrological in character.

GEORGE A. DAVIS, JR.
Buffalo, N. Y.

GALILEO—FIRST OBSERVER OF MARVELLOUS THINGS

Elma Ehrlich Levinger. Julian Messner, Inc., New York, 1952. 180 pages. $2.75.

THE TITLE of this book is taken from Galileo's own words as written in a letter, dated January, 1610, shortly after he had turned his newly devised telescope toward the heavens: "I give infinite thanks to God who has been pleased to make me the First Observer of Marvellous Things."

Anecdotes and facts about Galileo are well known. He has a number of astronomical discoveries to his credit: sunspots, four satellites of Jupiter, the rings of Saturn, which appeared in his little telescope only as "handles" to the planet. While the material is not new and such a small volume cannot go into every detail, nevertheless, a new biography designed for younger readers is very welcome. Adults also will enjoy the simple and easy style for a review of the best-loved stories of a great scientist.

From boyhood in his father's wool shop, days of doubt and ridicule at the University of Pisa, the glorious years of liberal thought and inquiry spent teaching at Padua, the return in honor to his beloved city Florence, and his triumph in Rome, to his trial before the Inquisition, physical blindness, and death in confinement, the story is pleasingly and sympathetically told. The various, changing, and sometimes conflicting facets of Galileo's personality are brought out. Mrs. Levinger has consulted numerous primary and secondary sources in her research and has found conflicting evidence. In the foreword she says that she has tried to select the facts which seem most reasonable. Indeed, she presents many of the favorite stories about Galileo as we are usually accustomed to hearing them.

Included in the book and adding to its interest are brief sketches of the lives of Copernicus, Tycho Brahe, and Kepler. Also an account is given of the visits of Torricelli and John Milton to the aged and renowned Galileo. Contributing to the book's usefulness is an excellent index.

The author is to be commended particularly for the vivid and natural way in which she makes characters and events come to life. Incidents such as the weight-dropping experiment from the leaning tower of Pisa, accidental discovery of the principle of the telescope by a Dutch optician, demonstration of the telescope in Rome, are told so interestingly that they may be used for retelling to school or scout groups. They would also lend themselves readily to dramatization.

Despite the long and careful preparation by the author, a few apparent errors have crept in. To astronomers the most important point of disagreement is with the statement on page 59 that Tycho Brahe "might have accepted the startling new ideas of Copernicus had he not felt them to be contrary to the teachings of scripture." Here the author seems to have overlooked the fact that Tycho's most serious objection to the Copernican theory of a moving earth was that the stars should show an annual parallax. Because his most careful observations could not reveal this, Tycho proposed a theory of his own to explain the facts as he saw them. Students will remember that the year of Copernicus' death and publication of his famous **De Revolutionibus** was 1543, rather than 1542, as stated on page 54. Isaac Newton was born in the same year that Galileo died, but some 11 months later, not on the same day (page 152).

RUTH HAYNER CRESSON
Swarthmore, Pa.

NEW BOOKS RECEIVED

INTRODUCTION TO GEOMETRICAL AND PHYSICAL OPTICS, *Joseph Morgan*, 1953, *McGraw-Hill*. 450 pages. $6.50.

This is a text for an intermediate course, designed for physics majors as well as for a general comprehensive treatment. A feature is the parallel development of many points with calculus and by noncalculus methods.

TABLES FOR ROCKET AND COMET ORBITS, *Samuel Herrick*, 1953, *U. S. Government Printing Office*. 100 pages. $1.75.

This book is No. 20 in the National Bureau of Standards Applied Mathematics Series. The introduction states that the anticipated development of rocket navigation has directed serious attention, for the first time, to rectilinear motion in the two-body problem. The tables make it possible to determine position and velocity from the time, for rectilinear orbits, by direct interpolation, without the aid of series expansions or successive approximations. The inverse process can also be solved, by inverse interpolation.

The tables may be used also for motion in ellipses and hyperbolas whose eccentricities are near unity, for instance, for comet orbits that have generally been treated as "nearly parabolic."

METHOD FOR DETERMINING THE RESOLVING POWER OF PHOTOGRAPHIC LENSES, *Washer and Gardner*, 1953, *U. S. Government Printing Office*. 27 pages. $1.00, paper bound.

This National Bureau of Standards Circular 533, superseding Circular 428, provides the photographer with two sets of charts by which the resolving power of a photographic lens may be measured numerically with respect to a definite scale of values. It gives a detailed description of the procedure and technique to be followed in order that comparable values may be obtained by different observers in widely separated laboratories. The average amateur photographer can use the method with equipment normally available or easily obtained, and it may also be applied to the testing of telescopes and binoculars for definition and to the testing of goggle lenses for definition and prismatic power.

The range of the charts is from 12 to 80 lines per millimeter. A process identical with that used in printing postage stamps insured exact duplications of the test patterns.

GEOLOGY APPLIED TO SELENOLOGY

By J. E. SPURR

"This is the first time that lunar features have been studied carefully by one trained and experienced in modern structural and igneous geology." — *Journal of Geology.*

Vols. I and II combined, FEATURES OF THE MOON, 1945, 430 pp., 95 text figures ..... $ 5.00
Vol. III, LUNAR CATASTROPHIC HISTORY, 1948, 253 pp., 47 text figures .. $ 4.00
Vol. IV, THE SHRUNKEN MOON, 1949, 207 pp., 36 text figures ..... $ 4.00
Complete Set $12.00

ROBERT A. SPURR
Box 413, College Park, Maryland

SPITZ LABORATORIES, INCORPORATED
is happy to announce that
MR. ROBERT R. COLES
at present Chairman of the
American Museum - Hayden Planetarium
New York
will shortly join its staff
as Special Consultant

UNITRON Leads in Value and Quality

It's Yours for the Asking - - the New Illustrated Catalog of UNITRON Refractors!

The overwhelming choice of leading universities and active amateurs the world over. The most complete selection of telescopes ever offered.

- LENSES are FULLY CORRECTED for spherical and chromatic aberration and are COATED for maximum brilliance and clarity of image. AIR-SPACED CELL insures freedom from "clouding" with age.
- EYEPIECES of the HIGHEST QUALITY . . . Orthoscopic, Achromatized Ramsden, Huygens.
- FINEST MATERIALS throughout. DURALUMINUM TUBE. Moving parts of BRASS carefully machined to close tolerances, and finished in CHROMIUM.
- MODERN DESIGN based on time-tested engineering principles. HANDSOME APPEARANCE to which no illustrations can do justice.
- STURDY TRIPOD may be folded for convenient storage.
- EQUATORIAL MODELS have slow-motion controls for **both** declination and right ascension.
- ALTAZIMUTH MODELS have slow-motion controls for **both** altitude and azimuth.
- VIEW FINDER with crosshair eyepiece gives wide field.
- RACK-AND-PINION FOCUSING.
- STAR DIAGONAL for easy observing at all altitudes.
- SUNGLASS for solar observation.
- ERECTING PRISM SYSTEM for TERRESTRIAL OBSERVATION may be used with any of the eyepieces to give the same complete range of terrestrial magnifications as for celestial observation.
- FITTED WOODEN CABINETS.

Unbelievably low prices! Outstanding features, performance, and workmanship impossible to duplicate even by paying considerably more.

2.4-INCH ALTAZIMUTH
UNITRON Model 114

Same optical specifications, eyepieces, and accessories as the 2.4-inch Equatorial described in the third column, but with altazimuth mounting and micrometric, spring-loaded, slow-motion controls for both altitude and azimuth. **Only $125**

1.6-INCH ALTAZIMUTH
UNITRON Model 127: Not Illustrated.

Objective: 42-mm. (1.6") diam., 700-mm. (27.5") focal length, f/17.5.
Eyepieces: 78x, 56x, and 39x included. 100x: $8.95 extra.

COMPLETE with tripod and altazimuth mounting, slow-motion controls for both altitude and azimuth, view finder, star diagonal, sunglass, eyepieces, wooden cabinet. Only $75

3-INCH ALTAZIMUTH
UNITRON Model 140: Not Illustrated.

Same optical specifications and accessories as the 3-inch Equatorial but with altazimuth mounting. 171x, 133x, 96x, 67x, 48x eyepieces supplied. Sunscreen not included, but available as accessory. **Only $265**

4-INCH ALTAZIMUTH
UNITRON Model 150: Not Illustrated.

Same optical specifications, eyepieces, and accessories as the 4-inch Equatorial, but with altazimuth mounting. Sunscreen not included, but available as accessory. **Only $465**

EASY PAYMENT PLAN

UNITRON refractors may be purchased on an easy payment plan. Write for details.

NEW CATALOG AVAILABLE!

If you have not already received your copy, we shall be glad to rush one to you. All models are illustrated and fully described. A special section contains valuable information to help you choose a telescope. Learn why the most wanted telescope in America today is a UNITRON. Don't miss the fine summer observing. Write for your free catalog at once.

Please address your card or letter to the attention of Dept. TA-8
Microscope catalog also available.

Setting New Standards for Excellence —

4-INCH EQUATORIAL REFRACTOR
UNITRON Model 152

Objective: 105-mm. (4.13") diam., 1,530-mm. (60.24") focal length, f/15.
Eyepieces: 255x, 219x, 170x, 122x, 84x, 61x. 382x and 38x eyepieces available at extra cost.

COMPLETE with equatorial mounting and slow-motion controls, tripod with levels, eyepiece shelf with battery-operated illuminator, setting circles and verniers, view finder (42-mm., 10x), sun projection screen, sunglass, star diagonal, erecting prism system, eyepieces, pocket eyepiece case, wooden cabinets. Only $785

3-Inch and 4-Inch Photographic Equatorials also available.

2.4-INCH EQUATORIAL
UNITRON Model 128

Objective: 62-mm. (2.4") diam., 900-mm. (35.5") focal length, f/15.
Eyepieces: 100x, 50x, 35x included. 150x: $14.75; 129x: $8.95 72x: $6.75 extra.

COMPLETE with equatorial mounting and slow-motion controls, tripod, view finder, star diagonal, erecting prism system, sunglass, eyepieces, wooden cabinets. Only $225

3-INCH EQUATORIAL
UNITRON Model 142

Objective: 78-mm. (3") diam., 1,200-mm. (47.2") focal length, f/16.
Eyepieces: 200x, 133x, 96x, 67x, 48x included. 171x: $8.95 extra.

COMPLETE with equatorial mounting and slow-motion controls, tripod, setting circles and verniers, view finder (30-mm., 6x), sun projection screen, sunglass, star diagonal, erecting prism system, eyepieces, pocket eyepiece case, wooden cabinets. Only $435

ACCESSORIES

VIEW FINDER: 42-mm. (1.6") coated achromatic objective. Illustrated on Model 152. 10x crosshair eyepiece. Furnished with mounting brackets. A wonderful accessory for your present telescope. .... **Only $18.00**

GUIDE TELESCOPE: 62-mm. (2.4") coated achromatic objective, 700-mm. (27.5") focal length. 78x crosshair eyepiece. Furnished with mounting brackets. Convert your present telescope for astrophotography ..... **Only $75.00**

EQUATORIAL MOUNTINGS

The equatorial mountings of the 3" and 4" refractors are available separately for those who already own the optical components. All parts are "oversized," insuring utmost stability. Exceptional values.
3" Mounting and tripod ..... **Only $198**
4" Mounting and tripod ..... **Only $370**

All Instruments Fully Guaranteed

Send check or money order or 25% deposit with balance C.O.D.

Telescopes shipped Express Collect.

UNITED SCIENTIFIC CO. 204-6 MILK ST. BOSTON 9, MASS.

GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

Limiting Visual Magnitudes for Small Telescopes

THE STANDARD FORMULA for the determination of the limiting magnitude that may be seen with a telescope of diameter **D** (clear aperture of mirror or lens) is given in Dimitroff and Baker's **Telescopes and Accessories** as:

$$m = 8.8 + 5 \log D.$$

For instance, the computation for a 4-inch objective indicates that such a glass cannot see beyond magnitude 11.8.

The writer has been an observer of variable stars for several years, however, and it has been his experience that stars of magnitude 11.8 are very easy to see with a 4-inch instrument. This cannot be caused by his acute vision or excellent local seeing conditions because he is gifted with neither of these.

In fact, on reasonably transparent nights, stars of magnitude 12.9 have been seen, and verified by comparison with the estimates of fellow observers in the American Association of Variable Star Observers. Therefore, to fit such an observation, the formula ought to read approximately:

$$m = 9.9 + 5 \log D.$$

With this formula for a 2-inch aperture, the limiting magnitude is 11.4. This result encouraged me to purchase and assemble a 2-inch refractor of 23.5 inches focal length, in the hope that, if such a magnitude could be reached, an instrument of this convenient size could be transported to observing spots without the trouble that attends moving the larger refractor. This proved to be the case, for an 11.2 comparison star to the variable RZ Scorpii was seen without much effort, and in the field of RU Librae one of magnitude 11.4 was seen.

Therefore, I am of the opinion that a good 2-inch refractor, especially if the lenses are fluoride coated, is perfectly suited to the instrumental requirements of variable star work, refuting the common belief that nothing smaller than a 3-inch glass can make a serious contribution to this branch of astronomy.

FRANK J. KELLY
380 S. Winooski Ave.
Burlington, Vt.

ED. NOTE: Dr. James G. Baker has kindly contributed some thoughts on the subject of Mr. Kelly's letter, which have been incorporated in the following discussion:

The aperture of the fully dark-adapted eye is, nearly enough, 0.3 inch, and the limiting magnitude to which it can see is commonly accepted to be 6.2. On a strict area basis, a 1-inch telescope should see 2.6 magnitudes fainter, for it has more than 11 times the area of the dark-adapted eye. Adding 6.2 and 2.6 gives the constant 8.8 in the original formula. When the equation is applied to any instrument, three assumptions are being made:

1. That 6.2 is the limiting magnitude for the dark-adapted eye. 2. That in going to an ideal telescope of 1-inch aperture, there is an increment which is calculable on a strict area-to-area basis. 3. That in going to larger apertures all telescopes are 100 per cent efficient.

The first assumption seems to be reasonable, although there is no doubt that there will be minor variations between individuals. Dr. Baker has experimented with the stars around the north pole of the sky to determine how faint he could see on the best nights. When his maps were reduced by another astronomer, it was found that he had seen only to magnitude 5.9; in the West he would expect to see probably to magnitude 6.1 or 6.2, but certainly not to the 7.3 magnitude that would be called for in Mr. Kelly's revised formula.

Thus, the eye does not appear to behave in the ideal manner of a simple optical system, and in the case of the second assumption the characteristics of the eye have to be taken into account. There are two phenomena that reduce the efficiency of the eye for star images when the pupil is at maximum size. Experimental data are not available with respect to the degree of reduction of efficiency for star images, so that we can discuss these phenomena only in a qualitative sense.

One is the spherical aberration of the eye, which, as in any optical system, increases with the pupil size and spreads the image on the retina, probably causing a decrease in visual acuity. The second is

Fecker
TELESCOPES

PRECISION BUILT
for the EXACTING AMATEUR
and the WORLD'S LARGEST
INSTALLATIONS

Designed and built for those who want only the very best. As distinguished in performance as in its trim design. It's everything you ever wanted in a truly quality telescope.

PRICED FROM $390.00

Write for free illustrated catalog and prices, today!

FECKER
SINCE 1891
J. W. FECKER, INC.
2016 PERRYSVILLE AVENUE
PITTSBURGH 12, PENNA.

ORTHOSCOPIC OCULARS

WE HAVE IN STOCK for immediate delivery the best eyepiece ever produced for astronomical and scientific work, with the following characteristics:

1. Four-element design giving a flat, beautifully corrected field of 50° covering more than 160 per cent of the area of the conventional Ramsden for the same power. This eyepiece is a "must" for RFT work.
2. Precision optical elements, magnesium fluoride hard coated, increasing the light transmission approximately 10 per cent.
3. Simple take-down for cleaning.
4. Precision metal parts black anodized for anti-reflection and ground to 1¼" O.D.
5. Clean mechanical design permitting comfortable observation and ease of focusing.

Price postpaid, $15.95 each

These eyepieces are produced in 8 mm., 16 mm., and 32 mm. effective focal lengths only.

CHESTER BRANDON

California residents, add 3% sales tax

Box 126, Montrose, California

TRIPLES 'SCOPE PERFORMANCE!

Sharper images at higher powers! A startling statement positively proven in 16-page telescopic educational matter sent free on receipt of self-addressed long envelope bearing nine cents (9c) return postage.

First, the Goodwin Resolving Power lens placed in front of eyepiece gives three times the magnification on each by lengthening your primary focal length angle up to three times, yet extends eyepiece out no more than two inches from normal. This alone sharpens definitions.

Next, by achieving your highest powers on more comfortable low-power eyepieces, you lessen image deteriorations due to short-focus acute bending of the convergent beam, since all usual eyepieces are f/1 or less.

Third, you get greater illumination and wider field by relieving tiny aperture restrictions of higher-power eyepieces.

The Resolving Power lens is achromatic, coated, gives flat field sharp to the edge. Here is astonishment in image improvements! Price $17.50 in 4" long chrome-plated adapter tube fitting standard 1¼" eyepiece holders ONLY (but adaptable to Unitrons). Money back if not delighted after two weeks trial!

No COD's — Colleges and Observatories may send purchase order.

FRANK GOODWIN

345 Belden Ave., Chicago 14, Ill.

WAR SURPLUS BARGAIN

OPTICS

ACHROMATIC TELESCOPE OBJECTIVES — Perfect Magnesium-Fluoride Coated and cemented Gov't. Surplus lenses made of finest Crown and Flint optical glass. They are fully corrected and have tremendous resolving power and can be readily used with ¼" F.L. eyepieces. Guaranteed well suited for Astronomical Telescopes, Spotting Scopes, etc. Gov't. cost approximately $100.00.

Diameter	Focal Length	Each
54 mm (2⅛")	300 mm (11.811")	$12.50
54 mm (2⅛")	330 mm (13")....	12.50
54 mm (2⅛")	390 mm (15.356")..	9.75
54 mm (2⅛")	508 mm (20")....	12.50
54 mm (2⅛")	600 mm (23½")...	12.50
78 mm (3 1/16")	381 mm (15")....	21.00
81 mm (3 3/16")	622 mm (24½")...	22.50
83 mm (3¼")	660 mm (26")....	28.00
83 mm (3¼")	711 mm (28")....	28.00
83 mm (3¼")	876 mm (34½")...	28.00
83 mm (3¼")	1016 mm (40")....	30.00

We can supply ALUMINUM TUBING for the above lenses.

SYMMETRICAL EYEPIECE LENS SET

Each set consists of two magnesium-fluoride coated and cemented achromats, and exact Gov't. spacing diagram. Gives wide flat field.

½" E.F.L. (20X) Lens Set 13-mm dia. $4.50

¾"E.F.L. (13X) Lens Set 18-mm dia. $3.50

Rectangular Magnifying Lens — Seconds, sells for $6.50. Size 2" x 4" ..... $ 1.00
First Surface Mirror 14"x16" ¼" thick.. 10.00
First Surface Mirror 8"x10" ¼" thick.. 4.25
First Surface Mirror 4"x 4" ¼" thick.. 1.50
First Surface Mirror 1¼"x1½" 1/16" thick .25
Optical Peep Sight — Use as camera view. finder, etc. Dia. 1½", weight 1½ oz. ... $1.00

LENS CLEANING TISSUE — 500 sheets 7½" x 11". Bargain priced at only $1.00

RIGHT ANGLE PRISMS

8-mm face .. ea. $ .75 28-mm face .. ea. $1.75
12-mm face .. ea. .75 38-mm face .. ea. 2.00
23-mm face .. ea. 1.25 47-mm face .. ea. 3.00

!!! NEW LOW PRICES !!!

BEAUTIFUL IMPORTED BINOCULARS

Precision made, at a low low price within the reach of every man's pocketbook. Complete with carrying case and straps.

6 x 15 Ind. Focus .. Coated $16.00*
8 x 25 Center Focus 23.30*
8 x 30 Center Focus 27.50*
7 x 35 Center Focus .. Coated ... 41.50*
7 x 50 Ind. Focus .. Coated 35.00*
7 x 50 Center Focus .. Coated ... 39.25*
10 x 50 Ind. Focus .. Coated 45.00*
16 x 50 Center Focus .. Coated ... 55.00*

*Plus 20% Federal Excise Tax

MOUNTED EYEPIECE has two lenses 29 mm in diameter. Cell fits 1¼" tube. 1¼" E.F.L. (8X) $4.50

Gov't. Cost $200.

3x ELBOW TELESCOPE — Makes a nice low-priced finder. 1" Achromatic Objective. Amici Prism Erecting System. 1¾" Achromatic Eye and Field Lens. Small, compact, light weight, 2 lbs.

Plain Optics $6.50 Coated Optics $10.50

"MILLIONS" of Lenses, etc. Free Catalogue

We pay the POSTAGE — C.O.D.'s you pay postage. Satisfaction guaranteed or money refunded if merchandise returned within 10 days.

A. JAEGERS 6918 Merrick Road Lynbrook, N. Y.

the Stiles-Crawford effect[1], whereby light passing through the peripheral regions of the pupil is not as effective in activating the cones of the retina as is light which passes through the center of the pupil. O'Brien[2] has suggested that the effect is the result of the shape of the cones and a breakdown of total internal reflection therein.

When we use a telescope, there is usually sufficient magnification to make the exit pupil quite small. In the case of Mr. Kelly's 2-inch telescope, a 1-inch eyepiece would give 23.5 power and an exit pupil 2/23.5 or 0.085" in diameter. The Stiles-Crawford effect would be absent, and the spherical aberration negligible. This would lead to the situation Mr. Kelly describes.

On the other side of the picture, large telescopes are not as efficient as small ones. The lack of adequate color correction in large refractors and the coma in reflectors both tend to diminish the amount of light reaching the eye. Thus, the increase in limiting magnitude with increase in aperture is probably not quite as rapid as the term 5 log **D** would indicate. For relatively large telescopes, the two discrepancies would tend to compensate, and the standard expression 8.8 + 5 log **D** would give a more nearly correct value than for smaller instruments. Atmospheric seeing, which is a function of focal length rather than aperture, also tends to reduce the efficiency of large telescopes. That is, as the focal length gets greater and greater, atmospheric seeing tends to diminish the surface brightness which the eye sees. Accordingly, for a very large telescope on reasonably good nights, it is probable that the figure of 8.8 in the original formula might even have to be decreased further.

It was suggested by Dr. Baker that if Mr. Kelly were to use a very low-power eyepiece on his 2-inch refractor, he could bring the deficiency of the eye into play. A lens of 4" focal length would give him only 6 power, and the exit pupil diameter would be 2/6 or 1/3", just filling the dark-adapted eye. If the eye is causing the trouble, the limiting magnitude should fall immediately to the value predicted by the 8.8 formula. Mr. Kelly now reports his experiments along these lines:

"Two avenues of observation were explored. One was to extend the curve of the revised formula beyond the two points previously established; the other was to discover whether the pupil of the observer's eye, when coincident with an exit pupil of about 0.3", could see fainter stars than a smaller pupillary diameter would allow. For the first part of the work, the following goals were set from the 9.9 formula: 4", 12.9 magnitude; 3", 12.3; 2", 11.4; 1", 9.9; ½", 8.4; ⅜", 7.8; and ¼", 6.9.

"The table shows that a pencil of light 1/16" in diameter can be the standard in considering the formula, for although a star may be seen with larger or smaller pencils of light, a diminished visual brightness will result.

"For the second part, a 2-inch telescope with a focal length of 8" was fitted with

1. W. S. Stiles and B. H. Crawford, **Proceedings**, Royal Society, **B112**, 428, 1933, and **B116**, 55, 1934.
2. Brian O'Brien, **Journal**, Optical Society of America, **36**, 506, 1946.

Complete Telescopes and Supplies

Ramsden Eyepieces
Combination Eyepiece and Prism Holders
Mirror Cells
Finders
Equatorial Mountings
Prisms

Send for a price list

C. C. YOUNG
25 Richard Road, East Hartford 8, Conn.

ESCO PRODUCTS

COMPLETE TELESCOPE OUTFITS AND KITS
High and low power eyepieces
Metal parts
Mounts
Cells
Large tubes from 4", 5", 6", 7" dia.

COMPLETE TELESCOPE ACCESSORIES
Front surface aluminizing
Grinding and polishing supplies
Lenses, Prisms, Filters

MIRRORS MADE TO ORDER

★ Free Catalogs ★

ESCO PRODUCTS
1426 Willow Ave., Hoboken, N.J.

BUILD YOUR OWN TELESCOPE

KITS: Complete with instructions, high quality materials, supplied at low prices.

Plate — $4.00 up Pyrex — $5.50 up

Lenses Cells
Prisms Eyepieces

Mirrors ground to your order.

Aluminizing — with the new
Quartz Coating

Satisfaction or Money Refunded

Write for Free Catalog

GARTH OPTICAL COMPANY
130 Garth Rd. Scarsdale, N. Y.

Astronomical Supplies

ORTHOSCOPIC OCULARS
All hard coated

28 mm. $13.00 7 mm. $15.50
16.8 mm. $13.50 4 mm. $16.50
10.5 mm. $14.75

Warranted to equal or surpass any oculars obtainable anywhere or money refunded.

Mirrors, kits, castings, spiders, flats, focusing devices, prisms, aluminizing.

Send for Catalogue.

Telescopics

1004 N. Seward St., Los Angeles 38, Calif.

BERAL COATINGS

The following prices now apply on **BERAL** coatings for telescope mirrors:

3" diam.	$2.50	8" diam.	$4.50
4" diam.	2.75	9" diam.	5.50
5" diam.	3.00	10" diam.	6.50
6" diam.	3.50	11" diam.	8.50
7" diam.	4.00	12½" diam.	9.75

All prices f.o.b. Skokie, Ill.
Minimum order $2.00

BERAL coatings are not overcoated with fluorides, quartz or silicon monoxide. They contain no chromium, and as a result they can be easily removed without danger of harming the glass supporting surface. The efficiency of **BERAL** coatings is uniformly higher, so that mirror performance is at its best.

LEROY M. E. CLAUSING
8038 MONTICELLO AVE. SKOKIE, ILL.

A NEW, RAPID-POLISHING PITCH

CYCAD OPTICAL PITCH

We are announcing this new polishing pitch for the attention of amateur and professional optical workers. CYCAD PITCH polishes faster than special laps such as beeswax, yet has all the advantages of pitch for producing fine optical surfaces. In actual tests, CYCAD PITCH with rouge has polished twice as fast as conventional pitch or beeswax laps with either cerium oxide or rouge.

Make polishing your mirror a pleasure instead of an ordeal — save hours of work with CYCAD PITCH.

Available in two grades: SOFT, a fast cutting grade for cold-weather use or for quick settling; HARD, the grade most professionals like. Intermediate hardnesses can be made by mixing the two.

$2.10 per pound, postpaid U.S.A., from

CYCAD PRODUCTS
Box 51, Crystal Lake, Illinois

HOW TO BUILD A QUARTZ MONOCHROMATOR for Observing Prominences on the Sun

By Richard B. Dunn

Telescope makers will be interested in having this valuable material easily available for reference, whether or not they plan to undertake construction of a quartz polarizing monochromator.

Price postpaid, 50 cents

SKY PUBLISHING CORPORATION
Harvard Observatory, Cambridge 38, Mass.

EVERYTHING FOR THE AMATEUR

TELESCOPE MAKER

KITS ..... $4.50 and up

ALUMINIZING
Superior Reflecting Surface, Fine Finish, Will not Peel or Blister. Low Prices.

Mirrors Tested Free | Prisms Eyepieces Accessories | Send for Free Catalog

MIRRORS MADE TO ORDER
SEND FOR FREE PRICE LIST

Precision Optical Supply Co.
1001 E. 163rd St., New York 59, N. Y.

ASTRONOMICAL INSTRUMENTS OF QUALITY

Optical Instruments including standard Telescopes and all accessories.

LABORATORY OPTICAL CO.
Plainfield, N. J.

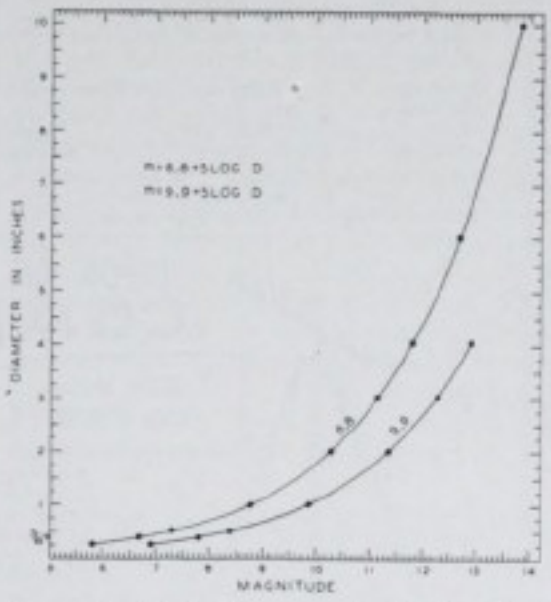
an eyepiece of 1½" e.f.l., giving an exit pupil 0.375" in diameter and assuring complete use of the pupil of an average observer's eye when opened to its largest size. When the field of R Ophiuchi was explored with this arrangement, the stars

OBSERVED LIMITING MAGNITUDES

AAVSO chart	Mag.	Aperture	Exit pupil
204016	12.9	4"	1/16"
203501	12.2	3"	1/22"
203501	11.4	2"	1/16"
170215	9.8	1"	1/16"
170215	8.6	½"	1/20"
170215	7.4	⅜"	1/16"
184205	6.7	¼"	1/24"

were apparently much more brilliant than usual and had a clearer background, and it seemed obvious that the faintest stars in the field could be seen. Nevertheless, a star of magnitude 9.8, previously seen quite comfortably with a 1/16" exit beam, could now only be detected with the greatest difficulty.

"The accompanying graph shows the relation of the two formulae for telescopes of sizes usually available to the observing amateur. The results of these observations show that the amateur cannot be like the camera enthusiast, who always uses a smaller opening to gain sharpness but is considered something less than expert if he uses a smaller diaphragm opening to take pictures under twilight conditions. The camera can make full use of its larger apertures because of skillful grinding of curves to accommodate them, but the eye is like a mirror with a poor edge. The brilliance of the field with a large exit pupil is apparently a diversion rather than a contribution to the problem of seeing faint stars."



A graph of limiting magnitudes for instruments up to 10 inches in aperture, showing curves for the standard formula and for the one proposed by Mr. Kelly. Note that as the aperture of small instruments is increased the limiting brightness becomes fainter more rapidly than for larger instruments.

GLEANINGS is always ready to receive reports and pictures of amateur instruments and devices, and is open for comment, contributions, and questions from its readers.

MAKE A PROFESSIONAL Astronomical or Terrestrial TELESCOPE for as little as $7.00

Now you can afford the luxury of a real telescope. See the mountains of the moon, Saturn's rings, nebulae and a host of heavenly wonders. We furnish the reflecting Mirror accurately ground, polished, and aluminized, together with a flat mirror and three lenses to make two eyepieces.

3" Kit....$ 7.00 5" Kit....$17.00
4" Kit.... 12.00 6" Kit.... 20.50

Send for your telescope kit now. Free instructions with kit. "Know-How" Catalog, 30c.

Or buy a complete instrument from us:
Stellarscope 3" (40x & 80x) $16.50
Deluxe Model 3" (40x & 80x) 35.00
Stellarscope 4" (60x & 120x) 26.00

EYEPIECES

Save Money — Make Your Own

It's simple. Use our All-in-One Hastings-Ross Achromatic Triplet lens system. You can hold these complete lens systems in simple bushings and have the equal of the world's finest eyepieces. Save money too.

20x or 1/2" E.F.L. Triplet Lens .. Only $6.80
33x or 1/3" E.F.L. Triplet Lens .. Only 6.80
40x or 1/4" E.F.L. Triplet Lens .. Only 6.80
50x or 1/5" E.F.L. Triplet Lens .. Only 10.00

TREMENDOUSLY WIDE FIELD
3-Element Achromatic Eyepiece

Six lenses! Finest eyepiece ever made anywhere. Our greatest buy. Made of 3 separate achromatic elements. All outside surfaces fluoride coated. In focusing mount. 1-13/16" (43 mm.) clear aperture, flat field to edges. Focal length 1¼" (32 mm.) (8x). 69° angle. Outside diameter of mount 2⅛" (54 mm.). Each $15.00 plus postage. The above with bushing to fit standard 1¼" eyepiece tubes. $18.00

Include postage — Remit with Order
No open accounts — No C.O.D.
Send 30c for "Know-How" Catalog

HARRY ROSS
TELESCOPES MICROSCOPES
Scientific and Laboratory Apparatus
70 West Broadway, Dept. ST-8B
New York 7, N. Y.

New Low Prices on PYREX Reflecting Telescope Kits

The most complete kits on the market.

In addition to the usual supply of abrasives, rouge, etc., you get the new, fast-polishing cerium oxide to save hours of work.

You can get a brass diagonal holder (spider) for only $1.00 additional if ordered with a telescope kit. Prices quoted below are for a Genuine Pyrex telescope blank and a plate glass tool.

PYREX MIRROR KITS

Diameter	Thickness	Price
4¼"	¾"	$ 5.50
6"	1"	$ 8.00
8"	1½"	$11.00
10"	1¾"	$19.00
12½"	2⅛"	$35.50

PLATE GLASS KITS

6"	1"	$ 5.50
7"	1"	$ 6.75
8"	1"	$ 8.00

PRISM .. 6½" long, 1⅞" face .. $3.25
PRISM .. 5½" long, 1½" face .. $1.85

Postage Paid to 1st and 2nd postal zones from N. Y. Add 5% 3rd and 4th zones, 10% 5th and 6th zones. Add 15% 7th and 8th zones.

Send for free catalog of optical supplies.

DAVID WILLIAM WOLF
74 Hunnewell Ave. Elmont, L. I., N. Y.

UNUSUAL OPTICAL BARGAINS

NOW! FOR THE FIRST TIME!

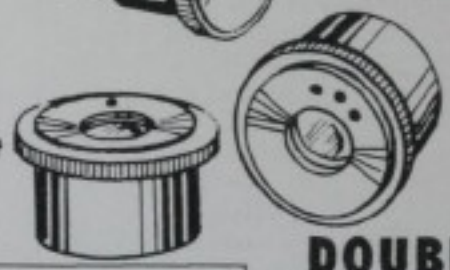
EDMUND PRESENTS

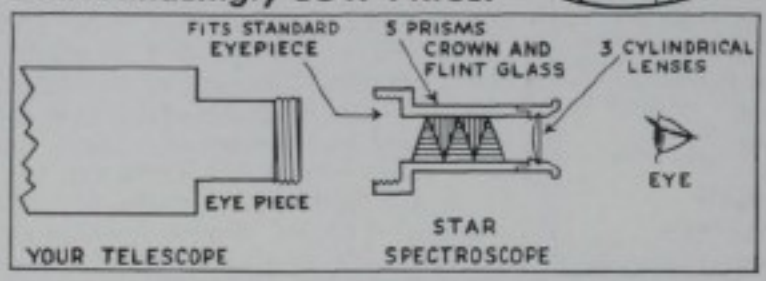
The Most Sensational Offering in Years . . .

STAR SPECTROSCOPE

AT ONLY **$32.75** Postpaid

Never Before Has There Been Available an Instrument of Such Fine Quality at Such Amazingly LOW PRICE!





DOUBLES THE USEFULNESS OF YOUR TELESCOPE

THE STAR SPECTROSCOPE MAY BE USED WITH THE FOLLOWING HUYGENS-TYPE ASTRONOMICAL EYEPIECES

Imported! Mounted! Fine quality — precision machined throughout. Standard 1¼" outside diameter.

Stock #	F.L.	Price Pstpd.
30,063-Y	6 mm. (¼")	$7.50
30,064-Y	12.5 mm. (½")	6.00
30,065-Y	10 & 20 mm.	8.00

(With Stock #30,065-Y you have a choice of 2 powers by rearranging lenses. Directions included. Chrome and black finish.)

In our opinion, this STAR SPECTROSCOPE is easily a $100 value, but since we were able to obtain this instrument from a famous, high-quality Japanese manufacturer, we are able to offer it to you at only $32.75 postpaid. Will open whole new fields of fascinating exploration and research. Study cosmic physics! Determine the chemistry of stars! Detect invisible gases thru dark-line spectra. Direct vision. 5 prisms. 3 cylindrical lens caps. Threaded to fit our Huygens-type astronomical eyepieces (as listed to left) or you can adapt to your own eyepiece. Unit is 2¾" long, comes in protective velvet-lined case.

Stock #50,023-Y . . . Star Spectroscope . . . $32.75 Postpaid

AMAZING Double Utility Combination 15X TELESCOPE and 35x ERECTING MICROSCOPE

Extra utility by removing telescope portion and using as 35 power microscope to inspect, dissect, etc. Telescope objective lens is achromatic, coated. Telescope can be removed and carried in pocket — focuses from 10 feet to infinity. Microscope has 3-element, color-corrected objective — image is erect, just as your eye sees it, not upside down as in an ordinary microscope. Ramsden eyepiece with coarse or fine focusing. Gives you 3" of working distance when used as microscope. Entire unit folds down to 2" x 7" x 10". Telescope instantly adjustable in height from 3" to 14".

Stock #70,017-Y ..... $29.50 Postpaid

A BRAND NEW IDEA! COMBINATION 50X MICROSCOPE AND 10X TELESCOPE

Amazingly practical and useful. Carry it right in your pocket—has convenient holding clip. The 50 power microscope is easily focused by tilting slightly. Achromatic objective lens. Used for any close-up examination or inspection. Just remove metal cap and draw out sliding tube for focusing telescope. An imported instrument at a bargain price. Chrome and black finish. Length closed 5"—dia. 11/16".

Stock #30,059-Y ..... $4.50 Postpaid

NEW 30 POWER TELESCOPE COMPLETE WITH TRIPOD

Unusual Bargain Price

A beautifully made, sturdy, imported instrument with dozens of uses. Spots 22-caliber bullet holes at 200 yds. You can see the craters on the moon! Excellent for amateur astronomers. All metal body — focuses from approx. 40 ft. to infinity. Achromatic objective — 40 mm. dia. — outside surface low-reflection coated. Smooth slide focusing eyepiece. Eye-lens outside surface coated. Lens erecting system. Images right side up. Sturdy tripod 8⅛" high. Can be used also for camera. Maximum length 26¼". Barrel diameter approximately 1⅞". Weight 1½ lbs.

Stock #70,018-Y ..... Only $21.95 Postpaid

TELESCOPE HOLDER — Most practical yet inexpensive scope holder ever offered. Threads into any standard camera tripod. Any diameter telescope up to 3" easily and firmly attached by means of sturdy straps with convenient tightening buckles. Full swivel.

Stock #30,053-Y ..... $3.50 Postpaid

FOCUSING EYEPIECE MOUNT

Made of brass. Will take a standard 1¼" outer diameter eyepiece. Will fit tubes from 3" dia. upwards by changing thickness of wooden wedges. Spiral focus travel 1-9/16". Easily attaches to your telescope with 4 screws and nuts.

Stock #50,019-Y ..... $7.95 Postpaid

TELESCOPE EYEPIECE — Consists of 2 Achromatic lenses F.L. 28 mm. in a metal mount.

Stock #5140-Y ..... $4.50 Postpaid

Same as above but about 1¼" extension has been added with O.D. of 1¼", which is standard for astronomical telescopes.

Stock #5223-Y ..... $5.25 Postpaid

ASTRONOMICAL MIRROR MOUNTS

Cast aluminum with brass mounting and adjusting screws and mirror clamps. Two sizes: for 6" mirrors — mount will fit 7" I.D. tube:

Stock #50,010-Y ..... $7.00 Postpaid

For 4⅛" mirror — mount will fit 5" I.D. tube:

Stock #50,011-Y ..... $5.25 Postpaid

LOOK AT THIS SPLENDID OFFERING...

COMET TELESCOPE

A $150 Value
Only $75.00

LOW PRICED, HIGH QUALITY REFRACTOR for ASTRONOMICAL and TERRESTRIAL USE!

1. Achromatic objective—diameter 42 mm. (clear aperture), focal length 750 mm.
2. Color corrected for secondary and primary spectrum.
3. 19X, 38X, 75X for astronomical observation.
4. 25X terrestrial observation. Image is erect.
5. Prismatic Diagonal for comfortable observing to the zenith.
6. Sun glass for solar viewing.
7. Adaptable to both 21 mm. and 1¼" eyepieces.
8. Sturdy tripod and mounting—leg length 51½".
9. Beautiful walnut-finished wooden case to hold telescope and accessories.
10. Instruction sheets supplied for each telescope.

Stock #70,009-Y ..... $75.00 F.O.B. Barrington, N. J.

BARGAINS GALORE! Get FREE CATALOG "Y"

If you haven't seen our big, FREE Catalog, you don't know what you're missing. Fantastic variety—never before have so many lenses, prisms, optical instruments, and components been offered from one source. Positively the greatest assembly of bargains in all America. Imported! Domestic! Telescopes! Microscopes! Hand Spectroscopes, Prisms, Lenses, Reticles, Mirrors and dozens of other hard-to-get optical items. Write for FREE CATALOG "Y".

Order by Stock Number . . . Send Check or Money Order . . . Satisfaction Guaranteed!

EDMUND SCIENTIFIC CORP. BARRINGTON NEW JERSEY

OBSERVER'S PAGE

Universal time is used unless otherwise noted.

An Artificial-Occultation Experiment

A DOMESTICATED MODEL of an eclipsing variable was described by Dr. William A. Calder in the March, 1952, issue of **Sky and Telescope**. Here is an equally tamed model of an occultation of a star by the moon.

At the far end of the room is placed an artificial star and moon, the latter being given a slow motion by a small motor. The moon thus occults the star at some point of its travel.

At the other end of the room a small refractor is focused on the star. A photomultiplier tube (931A) takes the place of the ocular and eye. The output of the multiplier is fed through a Kron-type amplifier to an Esterline-Angus recorder, the drum of which is run by an independent motor to give a speed of the chart of about 1½" per second.

A supplementary needle actuated by a small solenoid records the seconds ticks from Station WWV, using an ordinary short-wave receiver to which has been added a filtering system to keep out the audio-frequency tones, voice and code announcements. This system was built from information obtained from Edward A. Halbach, of the Milwaukee Astronomical Society. It works fairly well although subject to the inevitable fading and spurious signals due to static. The receiver is a simple surplus "command" set tuned to the 5-mc. channel. A ham radio receiver tunable to all the frequencies broadcast by WWV would be more suitable.

The tracing of an artificial occultation is reproduced here. The upper track records the seconds ticks from WWV; time proceeds from right to left. The lower track shows the output of the multiplier; at occultation there is a drop in the output.

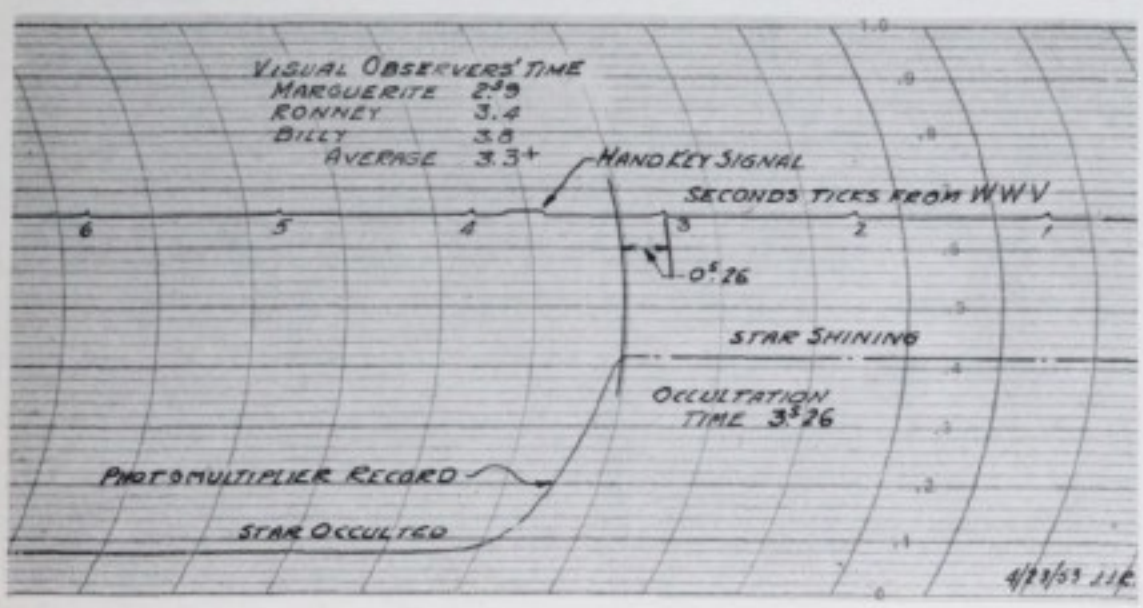
The time of the occultation can easily be determined to 1/100 second, but there are several reasons why the recorder needle does not come to zero (or dark-current value) instantaneously. The artificial star has a definite diameter and it takes a little time for the "moon" to traverse this distance, in this case approximately 1/20 second. Also, there is a Foucault fringe pattern which in effect extends the diameter of the star. But the greatest delay is due to the damping of the needle by the inkwell and the magnetic circuit. The Kron amplifier has a shunt condenser across the input resistor to give a time constant of one second, but it was removed for this occasion.

The most interesting part of this experiment was the comparison of the times of four observers with that of the photomultiplier. Three of the observers used ordinary stop watches and the AAVSO technique for timing occultations. In this method, a stop watch is started at the time of the occultation and stopped when the WWV signals come to an even minute. The fourth observer used a telegraph key which when pressed left a record on the time track; this record can easily be distinguished from that of the seconds ticks.

The key observer was almost 0.4 second slower than the photomultiplier, but the observers using stop watches seemed to obtain better results after a little practice. Three high-school seniors obtained the following times: Marguerite, 2.9 seconds; Ronney, 3.4 seconds; Billy, 3.8 seconds; average, 3.37 seconds. The photomultiplier gave the time of occultation as 3.26 seconds, as can be verified from the record. The spread of the three observers for this particular determination was 0.9 second, but after several trials they narrowed their spread considerably and came closer to the multiplier time.

The experiment was repeated several times with similar results, which are perhaps a little better than those reported by Mr. Halbach in the March, 1953, issue of **Sky and Telescope**. You will note that he reported a spread of 1.2 seconds for actual occultation observations, but the "domesticated" model affords far more favorable observing conditions for both the visual observers and the photomultiplier apparatus. An actual tracing of a real occultation not only shows less drop, but the record is very irregular before and after occultation due to bad seeing.

JOHN J. RUIZ
P. O. Box 115
Dannemora, N. Y.



For Sale

ZEISS "Starmorbi" BINOCULAR

New; 12-24-42 power; length about 20", weight about 7 lbs. In new leather carrying case. No tripod.

Asking price, $1,000.

Owner: E. M. Lipman
5202 Wythe Ave., Richmond, Va.

SKY-SCOPE

The new and improved 3½-inch Astronomical Telescope that amateurs everywhere are talking about.

Completely Assembled—**$29.75**
Equatorially Mounted, 60 Power
¼-wave Aluminized Mirror
Ramsden Type Ocular
125x & 35x Supp. Eyepieces, ea. **$5.00**
6-power Finders .... postpaid, ea. **$7.30**

We invite your attention to our free brochure describing in a straightforward manner the instrument's amazing performance.

THE SKYSCOPE CO., INC.
475-s Fifth Avenue, New York 17, N. Y.

THE OBSERVATORY
A Magazine for Everybody Interested in Astronomy
Founded 1877
Current developments in astronomy illustrated by means of articles, correspondence, notes on discoveries. Reports of the meetings of the Royal Astronomical Society of London; the Darwin and Halley lectures.
Single copies, 60 cents
Annual subscription for 6 issues, postage paid, $3.00 to: The Editors
ROYAL GREENWICH OBSERVATORY
Herstmonceux Castle
Hailsham, Sussex, England

Time Is Marching On

Soon the cool September nights will be here with improved seeing. You will want to get out in the crisp air and LOOK. In the meantime why not sit in the shade and brush up on celestial mechanics with our chart sets? Be ready for coming good seeing. Place your order for charts now — and why not for slides too, and save?

A new chart set on the sun is coming soon. Watch for the announcement.

2 slide sets — 2 chart sets $24.50
2 slide sets — 1 chart set $21.50
1 slide set — 2 chart sets $15.25
1 slide set — 1 chart set $12.25

2 slide sets .. $18.50 1 slide set $9.75
2 chart sets ... $6.25 1 chart set ... $3.50
Single slides .... $.50 Single charts .. $.20
Large charts (27" x 35") ..... each $3.50
(Discounts on quantities)
Small chart sets 8½" x 11" — punched.
Send a card — new circular just out.
Projector circular if you ask for it.

ASTRONOMY CHARTED
33 Winfield St., Worcester 2, Mass., U.S.A.

HELIACAL RISING OF MARS

MARS' current synodic revolution began with conjunction with the sun on July 8, 1953, and will be extremely favorable for observations of the planet's heliacal rising and setting, providing an excellent opportunity to watch the planet move all the way around the ecliptic between two consecutive solar conjunctions.

Based on my experience observing Mars' heliacal setting this past spring, I suggest that one first watch for it on the morning of August 15th. The brighter planet Mercury will be a guide to the location of the ruddy planet, while Venus and Jupiter will serve as conspicuous pointers for Mercury. Venus will be nearly at the midpoint of the great circle arc between Mercury and Jupiter, and all of the planets will be close to the ecliptic. Having reached greatest elongation west two days earlier, and although rising after dawn has begun, Mercury will be brilliant enough to be easily seen with the unaided eye.

In order to locate Mars, 7½° east of Mercury, optical aid will be necessary. A keen test for a 6-inch telescope at moderate power will be the stars of Praesepe in Cancer, located midway between the two planets. This will require a very clear atmosphere as well as a low horizon.

It will be easier to detect Mars eight days later when, on the morning of August 23rd, it comes close to Mercury. Conjunction occurs at 14 hours UT, with Mars 6' north of Mercury, so that the two will appear very close together generally everywhere in the Western Hemisphere. Although a little closer to the sun in apparent position than on the 15th, Mercury will have increased slightly in brightness.

By mid-September, Mars will rise before dawn and be quite conspicuous. There should be no difficulty detecting it without optical aid on the morning of September 13th when it passes 47' north of Regulus.

There are two geometrical reasons why 1953 especially favors northern observers in viewing the heliacal rising of Mars very shortly after conjunction with the sun. First is the large angle between the ecliptic and the horizon at sunrise on mornings of late summer. Second is Mars' nearness to aphelion in its orbit, which it will reach on October 26th; hence its eastward motion among the stars will be nearly at its slowest. The result is that after conjunction the sun will appear to draw away from Mars in the sky more rapidly than usual, and the planet will become visible after a minimum number of days have elapsed.

The writer's observations mentioned above were made in Rochester on evenings this spring. On May 23rd, with a 2-inch refractor of 8 power, Mars was last detected. In a 3-inch refractor of about 30 power, the shape of the disk was readily discerned, and the atmospheric dispersion rendered the upper limb noticeably bluer than the lower limb when the planet was near the horizon. On June 1st, Mercury was first observed under the same conditions, and the confirmation of a disk was similarly made. Although the two planets were near conjunction on this latter date, a futile attempt was made to detect Mars. On neither date was the visible planet seen with the unaided eye, but Mercury was so observed on June 7th.

This synodic period of Mars includes the favorable opposition of June 24, 1954, best observed in the Southern Hemisphere; this opposition will be nearly as favorable as that of 1956.

PAUL W. STEVENS
2322 Westfall Rd.
Rochester 18, N. Y.

MINIMA OF ALGOL

August 1, 8:00; 4, 4:49; 7, 1:37; 9, 22:26; 12, 19:14; 15, 16:03; 18, 12:52; 21, 9:40; 24, 6:29; 27, 3:17; 30, 0:06. September 1, 20:54.

These minima predictions for Algol are taken from the 1953 **Handbook** of the Royal Astronomical Society of Canada.

OCCULTATION PREDICTIONS

Data for the occultations of 17, q, and 20 Tauri on August 2-3 and for 125 Tauri on August 4-5 were published on the Observer's Page last month. Predictions are for stations **H** and **I** only.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

The Ring nebula in Lyra, M57, photographed by Claude B. Carpenter with a 12½-inch Newtonian reflector of 87 inches focal length. A 6½ x 9-cm. camera was used at the prime focus, permitting an eight-times enlargement of this 30-minute exposure.

DEEP-SKY WONDERS

JUST AS M13 is the best-known globular cluster (see July Deep-Sky Wonders), so M57, the Ring nebula in Lyra, is the most popular of the planetaries. It seems to have been discovered by Darquier in 1779, and he and Messier saw it in their imperfect instruments as a pale planetary disk. By Herschel's time its "smoke-ring" form was known and justly admired. In small telescopes with low powers its ring character may be hard to discern (finders often do not show it at all), but a 10-inch with 100 power reveals beautifully the clean-cut edges and the darker center, although it takes a very large instrument to show the blue central star which provides the high-frequency radiation for the shell.

Messier 57 differs from most planetaries by the almost perfect sharpness of its outlines, and the completeness of the ring form, in contrast to such objects as the Dumbbell nebula, where visual scrutiny would never suggest the typical planetary construction. However, long-exposure photographs of M57 show a second ring outside the first, of a fragmentary and curdled appearance.

Also designated as NGC 6720, M57 is easily found halfway between Beta and Lambda Lyrae, at $18^h\ 51^m.7$, $+32°\ 58'$. It is oval, 80" by 60", and is of the 9th magnitude visually.

The constellation of Lyra, surprisingly, considering its position near the Milky Way, has only one other deep-sky wonder besides M57, and that is the little-known M56, NGC 6779, a pleasing globular cluster at $19^h\ 14^m.6$, $+30°\ 5'$, diameter 5'. But while the Ring nebula is about 5,000 light-years away, the globular lies far out in space at more than 60,000 light-years. Yet both shine brightly in the amateur's instrument—here is material for intellectual contemplation of the purest sort.

WALTER SCOTT HOUSTON

SKY-GAZERS EXCHANGE

Classified advertising costs 10 cents a word, including address; minimum charge $2.50 per ad. *Remittance must accompany order.* Insertion is guaranteed only on copy received by the 20th of the second month before publication; otherwise, insertion will be made in next available issue. We cannot acknowledge classified ad orders. Sky Publishing Corporation assumes no responsibility for any statements made in the classified column, nor for the quality of merchandise advertised. Write Ad Dept., Sky and Telescope, Harvard Observatory, Cambridge 38, Mass.

WANTED: Discarded telescope lens, 5" or larger. Will pay according to merits. $15.00 or more. C. W. Trumbull, 1305 N. Glen Oak, Peoria, Ill.

FOR SALE: 5½" refractor by Petitdidier, with eyepieces, tripod. Best offer. Harold Tilton, Moultonboro, N. H.

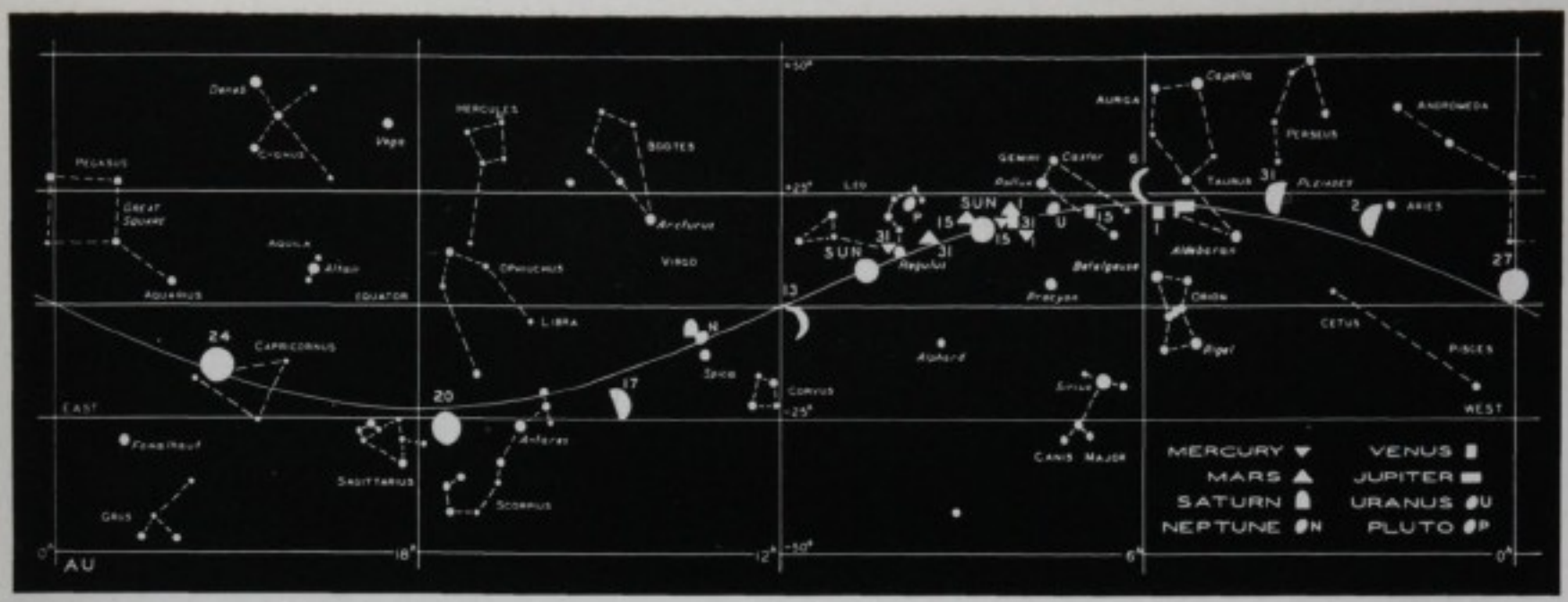
NEW BOOKS: Moore, "A Guide to the Moon," $3.95; Davidson, "Astronomy for Everyman," $5.00; Norton's "Star Atlas and Reference Handbook," latest edition 1950, $5.25. Write for list. Herbert A. Luft, 42-10 82nd St., Elmhurst 73, N. Y.

FOR SALE: 12" Hearn telescope. Automatic drive, Beral-coated mirror and diagonal. A fine instrument. Price $650.00 F.O.B. T. J. Baxter, Baxter's Inc., New Bern, N. C.

FOR SALE: 6" reflecting telescope; unmounted; objective, f/8, professionally ground; rack and pinion focusing; spider prism holder; two eyepieces. $100.00. Correspondence invited. Milburn Guillory, 1752 Marye St., Alexandria, La.

FOR SALE: Hand-made aluminum 6" reflector and 5 eyepieces, $88.00. Write to L. Wecker, 62-65 Saunders St., Rego Park, N. Y.

REFRACTORS: 4" Bardou, Unitron, Sans and Streiffe. Complete with mounting and accessories that make observation a pleasure. Quality plus economy. Rasmussen and Reece, Amsterdam, N. Y.



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

The sun will be partially eclipsed on August 9th, but this event will be visible only in the southern tip of South America and the Pacific Ocean. The magnitude of greatest obscuration will be 37%.

Mercury will be a morning object all month, attaining greatest elongation on August 13th, 18° 49′ west of the sun. The elusive planet can be observed from about the 7th to the 27th. Of magnitude +0.2 at elongation, it will rise 1½ hours before sunrise. On the 27th, Mercury will be at magnitude −1.3, rising an hour before the sun.

Venus, as it travels through Gemini, rises about three hours ahead of the sun all month. In mid-August the planet will be at magnitude −3.5, with a disk 15″ in diameter, 73% illuminated as seen in a telescope.

Mars becomes visible toward the end of August as a 2nd-magnitude object in the morning sky. On the 23rd, a close conjunction occurs with Mercury, the latter being 6′ south of Mars at 14 hours UT. The pair rises over one hour before the sun; slight optical aid may have to be used to view this event.

Jupiter, located to the south of Beta Tauri, rises at midnight in late August. Continuing its eastward motion among the stars, Jupiter appears at magnitude −1.8. Telescopically, the planet presents a disk of 36″ equatorial diameter on the 15th.

Saturn appears low in the west, setting 2½ hours after the sun in mid-August. Moving eastward about 5° north of Spica in Virgo, Saturn shines at magnitude +1.0. On the 15th, the ring system is inclined 13° to our view and is continuing to open.

Uranus may be viewed with slight optical aid after August 7th in the morning sky. It is moving eastward about 2½° due east of Delta Geminorum. On the 22nd, Venus passes 1° 19′ south of Uranus.

Neptune will be observable in the evening sky for the last time this year. Located about 1° west of Saturn in early August, Neptune remains at the 8th magnitude. On August 19th, this planet will be exactly 4° north of Spica.

Pluto is in conjunction with the sun on August 16th at 1:00 UT.

E. O.

MOON PHASES AND DISTANCE

Last quarter	August	2, 3:16
New moon	August	9, 16:10
First quarter	August	17, 20:08
Full moon	August	24, 20:21
Last quarter	August	31, 10:46
New moon	September	8, 7:47

			Distance	Diameter
	August			
Apogee	13,	7h	252,200 mi.	29′ 26″
Perigee	25,	18h	222,700 mi.	33′ 20″
	September			
Apogee	9,	16h	252,600 mi.	29′ 23″

PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

Elektra, 130, 9.6. Aug. 11, 22:55.3 −11-35; 21, 22:50.3 −13-52; 31, 22:44.2 −16-14. Sept. 10, 22:37.7 −18-30; 20, 22:31.8 −20-27; 30, 22:27.4 −22-01.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1953.0) for 0h Universal time. In each case the motion of the asteroid is retrograde. Data supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

AUGUST METEORS

This year we are highly favored by the absence of a bright moon during the first half of August. The Perseid shower may be observed during this entire period. The maximum occurs August 11th through 13th, with rates up to 70 per hour under good sky conditions after midnight. Rates for the first two weeks of the month are better than 20 per hour, and after the 7th over half the meteors seen will be Perseids. The radiant is diffuse and of the moving type; at maximum it is to the north of Eta Persei. Perseids are swift, often leaving trains, and many are quite bright and at a distance from the radiant they present long trails.

E. O.

SUNSPOT NUMBERS

May 1, 39, 46; **2**, 39, 40; **3**, 32, 35; **4**, 15, 26; **5**, 11, 9; **6**, 10, 8; **7**, 9, 8; **8-14**, 0, 0; **15**, 1, 0; **16**, 0, 7; **17**, 5, 8; **18**, 3, 14; **19**, 13, 10; **20**, 12, 10; **21**, 11, 11; **22**, 12, 11; **23**, 13, 11; **24**, 13, 13; **25**, 14, 18; **26**, 12, 11; **27**, 13, 10; **28**, 16, 18; **29**, 19, 23; **30**, 22, 18; **31**, 6, 17. Means for May: 10.9 American; 12.3 Zurich.

Daily values of the observed mean relative sunspot numbers are given above. The first are the American numbers computed by Neal J. Heines from Solar Division observations; the second are the Zurich Observatory numbers.

LUNAR CRATER CATALOGUE

Recently, a mimeographed catalogue of lunar craters compiled by the late Dr. J. Young has been published by D. W. G. Arthur, himself a lunar observer, who writes:

"The manuscript and some of Dr. Young's notebooks came into my hands several years after his death. I have recently had permission of the British Astronomical Association to publish. The catalogue is essentially a list of diameters and an attempted classification of all craters greater than 10 miles in diameter within 70° of the center of the moon's disk and of named craters outside these limits.

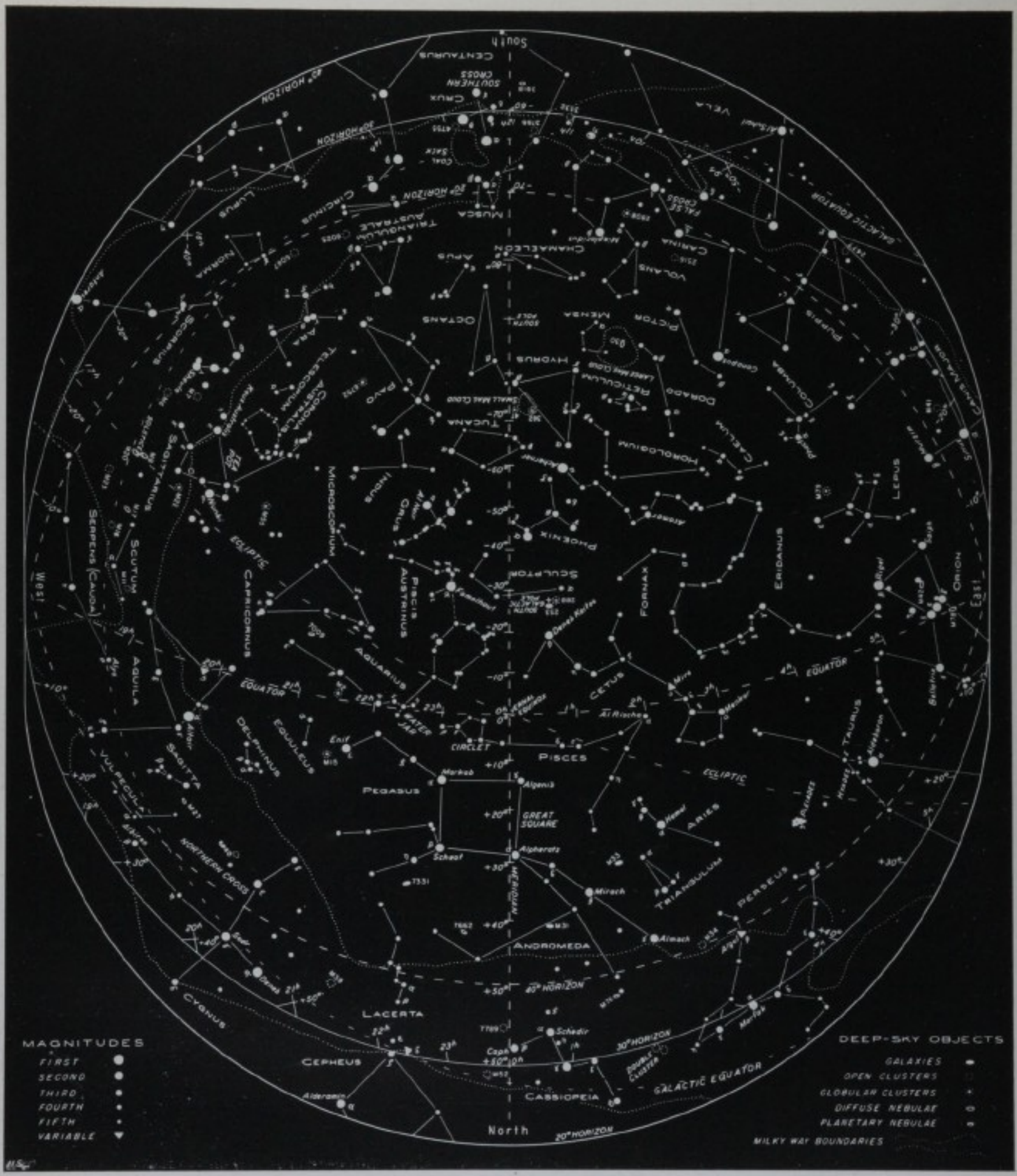
"The notebooks indicate that the measures were far more precise than any previous ones, so the work is a notable contribution to the statistics of selenography. My own catalogue is more extensive, but since it is far from complete, Dr. Young's work should prove extremely useful to all who are interested in selenography."

The 30-page catalogue may be ordered from Mr. Arthur, 17 Waterloo Road, Wokingham, Berks, England, for 3s 6d.

VARIABLE STAR MAXIMA

August 7, T Cephei, 210868, 5.8; 13, R Ophiuchi, 170215, 7.6; 15, R Sculptoris, 012233a, 5.8; 19, RT Hydrae, 082405, 7.6; 22, S Herculis, 164715, 7.6; 24, U Octantis, 022813, 7.5; 24, R Doradus, 043562, 5.8; 25, Z Pegasi, 235525, 8.4. September 2, R Cassiopeiae, 235350, 6.5.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.



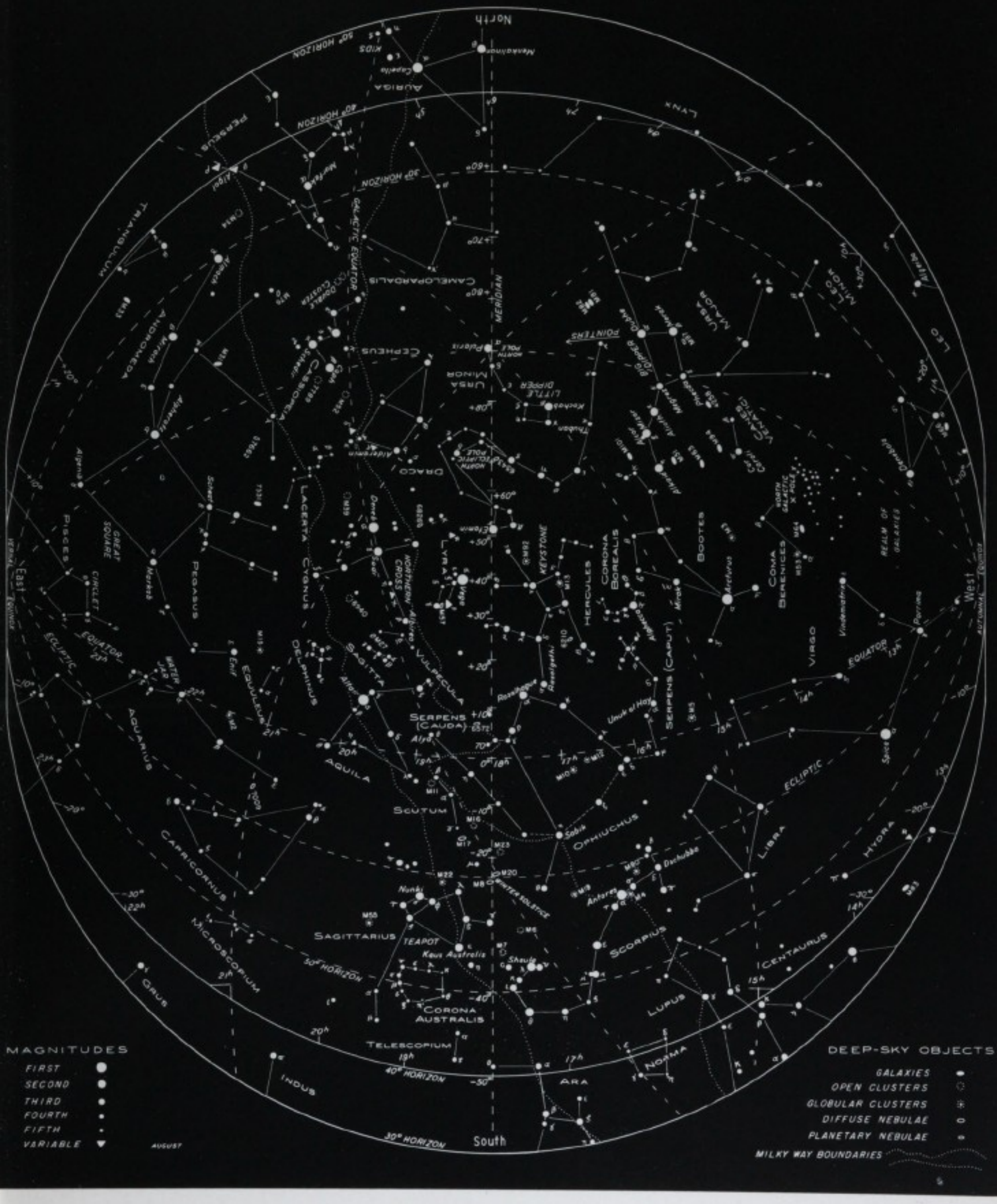
The sky as seen from latitudes 20° to 40° south, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of November, respectively.

SOUTHERN STARS

CENTERED in this chart of the southern heavens is the portion of the sky that ancient constellation makers peopled with animals and objects of the sea, with Aquarius, the Water Carrier, perhaps the most important.

In his book, **The Stars in Our Heaven** (Pantheon, 1948), Peter Lum devotes a chapter to the six principal constellations of the ancient celestial sea: Aquarius; Capricornus, the Sea-goat; Cetus, the Whale; Piscis Austrinus, the Southern Fish; Pisces, the Fishes; and Eridanus, the River. He states that while we do not know the origin of this sea, it was a concept familiar to the early inhabitants of the Tigris-Euphrates region.

In Babylonian mythology, Tiamat was a "powerful dragon-goddess of the primeval sea who rebelled against the gods of heaven and . . . created out of the chaos of her watery kingdom a great array of creatures half fish, half man, and with the help of these dark monsters she defied and nearly defeated the powers of light which were arrayed against her." Author Lum notes that the sea and its rainy constellations may be simply Tiamat and her monsters exiled to the skies after they had been overcome by the sun-god Marduk.



STARS FOR AUGUST

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of August, respectively; also, at 7 p.m. and 6 p.m. on September 7th and 23rd. For other times, add or subtract ½ hour per week. When facing north, hold "North" at the bottom; turn the chart correspondingly for other directions. The projection (stereographic) shows celestial co-ordinates as circles.